TRANSACTIONS

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TRANSACTIONS

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ROYAL SOCIETY OF SOUTH AFRICA.

VOL. XXVI.

PIPES AND SMOKING IN SOUTH AFRICA.

By P. W. Laidler, F.S.A.Scot., F.R.A.I.

(With Plate I and two Text-figures.)

TABLE OF REFERENCES TO COLLECTIONS.

P.W.L.	Writer's collection.
W.W.R.M.S. . .	Witwatersrand University Medical School.
B.A.	Bureau of Archaeology, University of Witwatersrand.
A.	Albany Museum, Grahamstown.
K.	McGregor Museum, Kimberley.
J.M.M. . . .	Johannesburg Municipal Museum.
B.	Bloemfontein National Museum.
E.L.	East London Museum.
P.E.	Port Elizabeth Museum.
M.	Maseru Museum, Basutoland.

Introduction.

The subject of pipes of stone, bone, or pottery of South African workmanship, and their significance as dating factors in later archaeological deposits, belongs to that recent phase of pre- or proto-history of Africa which has received scant attention, generally being relegated to the obscurity of "kaffir goed." The early records are clear and unequivocal ; the subject was made complicated only by the statements, frequently unsupported by evidence, of the writers of the nineteenth century.

Eva, the Hottentot interpretress, told van Riebeck (1, *a*) that her people ate dagga, which made them drunk, and that the drug was highly

esteemed among them. Van Meerhof, the surgeon (1, *b*), in his account of his travels in the North-Western Cape in 1661, states that the Hottentots tried to smoke, but for the most part could not. The king blew through the pipe presented to him and did not draw. The only Hottentot who understood smoking method and knew the use of the pipe was one who had previously visited the Cape. The surgeon then taught the king how to smoke, "so that there has come a madness for tobacco among them." This statement by a reliable observer indicates that, though the effect of dagga chewed was known and appreciated, there was no smoking of that herb in Southern Africa. The numerous occasions during these early years on which tobacco was given to Hottentots were occasions on which pipes also were presented.

There was a trade contact between the Namaquas and the peoples of the north-east (2), who belonged to the stone-building culture. But smoking had not yet spread from north-east to south-west. In the east there was considerable contact between the bushmen of the Free State, Basutoland and Stormberg, with the same tribes (3). Smoking among both Bushmen and Hottentots of the Cape area appears, then, to be of late introduction, *i.e. circa* seventeenth century.

The tribes in the neighbourhood of the Gamtoos River *circa* 1689 (4) bartered dagga from the coast tribes, and used it as the Indians used opium. By 1705 the tobacco and dagga trade with Hottentots to east and west was fully established (5, 6, and 7), and smoking was established among all tribes, including the Bushman. By the mid-nineteenth century (8), pipe bowls of wood, reed, stone, bone, or pottery were fixed to an eland horn, and the horn filled with water; in these pipes the Bushman smoked a mixture of dagga and powdered channa bush, which was very intoxicating. The pipe bowl was carved (9), and the pipe built up as required. Often the bowl was dispensed with, and he made a hole in the ground, in which he placed his tobacco, inserted a pipe through a small tunnel, and lay down to smoke it. This method was also at times combined with the use of water, though there is no evidence to suggest that the use of water was universal.

Commandant Bowker stated that 'kwes, *i.e.* perforated digging-stones, were used by Bushmen for smoking wild hemp (10), and that he had collected a number in the Tsomo area of the Transkei which weighed from three to seven pounds each, made of a soft sandstone, which was not fitted for use as a hammer or makeweight. In this connection it is of interest to recall the find of a bone "'kwe." Bowker stated that the large bored stone was placed on the ground over a hollow chamber, while the smaller ones were fitted with clay to hold the end of a cow's, goat's, or wild buck's horn, according to the size of the stone. Water was used in the chamber.

Mr. Smit, of Telemachus Kop, Aliwal North, tells that in his youth he saw an old Bushwoman smoke dagga in the long bone of a buck, so cut that it tapered from the bowl end to the mouthpiece.

The Basuto recognised two distinct branches of Bushmen (2). Among both, expert stone-cutters were found who made digging-stones and pipes for smoking hemp from 4 to 6 inches long.

After these clear records certain writers complicate the problem. Ellenberger mentions that the Bushmen made long pipes, but does not mention carving. Dornan says they carved pipes, but is indistinct on the point whether or not the carving operation refers to the manufacture of the pipe or its ornamentation. On the introduction of tobacco from the north there is greater unanimity, but on the introduction of the pipe, or its invention, none is certain. The only certainty is that the tribes of the Southern Cape were not smokers, they made no pipes at the time of van Riebeck's landing in 1652 or for many years thereafter, and, as shown by Eva and van Meerhof in the mid-seventeenth century, they needed to be taught how to smoke. Chewing of narcotic dagga preceded smoking of any narcotic substance.

Stow, writing in 1880 (8, p. 52), states that all tribes then found in South Africa were smoking and drinking ages before they knew of the existence of Europeans. "Their pipes were made of wood, reed, stone or the bone of an antelope. They were generally made in the shape of a tube rather wider at oné end than the other. Joints of mountain bamboo were also used, as well as bowls of baked clay." That writer describes the horn water pipe with cylindrical bowl, elaborately carved, as Bushman, and describes one seen by him in the possession of a Basuto who had obtained it in a Bushman cave. Zulus and other tribes, states Stow, used a similar pipe, substituting, however, the horn of an ox or a calabash "for the more primitive eland's horn used by the Bushmen. As it is evident that the hunters were addicted to smoking, and used these pipes generations before they came into contact with the stronger races, it becomes a question whether the latter did not copy the idea from the older inhabitants."

Stow believed that hemp smoking preceded tobacco smoking (and he states that Kanna bosch also was dried and powdered and used both for chewing and smoking), and that smoking among Bushmen preceded the appearance in South Africa of European or Bantu.

Ellenberger (12) also remarks that at one time the Bushman had no knowledge of tobacco, but smoked hemp, passing the fumes through water, and using an eland's horn, and also suggests, on evidence which is not recorded, that the Bushman smoked hemp before he smoked tobacco and that he taught the Basuto to smoke hemp.

The Bechuana named both smoking and snuffing *choca*, which signifies properly smoking (6, ii, p. 390). In 1806 it was recorded (6, ii, p. 373) that the Bechuana called tobacco *montjako*, and that its use prevailed long before the appearance of the European in Southern Africa.

Ellenberger (12) believed that the Bantu were acquainted with the use of tobacco before they came into contact with Europeans. Casalis (31) believed that the Bantu use of tobacco could be traced to the Portuguese of Mozambique, but that the use of dagga was more ancient. The names under which tobacco is known to the natives of Africa fall into three groups (14):

(i) Portuguese: *folka*, a leaf; *fumo*, smoke; adopted in twenty-eight instances.

(ii) Tobacco arises from the Persian *tumbaka*, and Turkish *tubeki*, from Persian influence on the east coast of Africa "from the eighth century," *e.g.* the Swahili *tumbako*.

(iii) Thirty instances stand for *punga*, from the Indian bazaars.

That writer (14) considers that the philological facts also suggest the possibility of tobacco replacing hemp in the water pipe of Africa, and then the water pipe being dropped for the ordinary pipe. The introduction of the substance tobacco and its name could not, however, be so early as the eighth century A.D., and is doubtfully so early as the mid-seventeenth century historical Cape tobacco trade, because though smoking was universally prevalent in the Americas during the pre-Columban era, the first information obtained by Europeans on the subject of smoking and snuffing was through Columbus in 1492. Mexican tobacco was described in 1542 (15); the plant, all varieties of which are American in origin, was first brought to Europe in 1558, after which date its use spread rapidly among the European nations, particularly during the seventeenth century, and *from them to the Turks and Persians*. There is, however, a complication, and pipes are found, it is stated, with human remains suggesting that herbs or hemp were smoked before this. The hemp plant is a native of Asia, and its use originated in Near Asia (16) as a medicinal and dietetic substance previous to its being smoked. It is suggested that in the Near East the Persian water pipe developed after the introduction of tobacco.

Dagga (*Leonotis leonurus* or *Leonotis* spp.) replaces *Cannabis indica*, or hemp, in South Africa. The plants appear to grow generally throughout South Africa and to be indigenous. The plant is an item of the Nama Hottentot herbal (17), being chewed or used in decoction or ointment.

Among the Ba Ila of Northern Rhodesia the men make the pipes, the women the domestic pottery. Pipes of natives dwelling north of the Zambesi are mostly of the angular type, into the stem side of which a

reed or wood shaft is inserted. They are essentially of Arab appearance. The use of the loose mouthpiece is general and occurs in the south in the wooden pipes of the modern Xosa, Tembu, Fingoes, and others. The Zambesi pipe bowls may be extremely ornate, as among the Makonde. In Southern Rhodesia the Matabele carve stone pipe bowls and use them on a horn. Dagga smoking is mentioned as a vicious practice of the Makalanga late in the nineteenth century. It is now widespread among all Bantu tribes.

In the Transvaal tobacco was grown by the Bavenda for a very long time, but was used only as snuff up to recently, prepared in a special pot, the interior of which was roughened by pre-firing incisions. Leakey found similar sherds in Kenya (18), in an association for which great antiquity is claimed, which would far exceed the limits of Arab and Moorish influence, but which are of doubtfully correct ascription. The modern Bavenda pipe is an ox horn filled with water, in which a hollowed reed is inserted, and to which is attached a clay or stone bowl. A similar type of pipe was used by the Bechuana and is illustrated by Thompson (7).

The Bahurutsi of the Western Transvaal appear not to be a smoking people to-day. In times past, however, they made, according to Chief Manyani, the horn water pipe with soapstone bowl. Occasionally dagga is smoked in the brick water pipe or in the ground-reed water pipe. All such smoking pipes (except the brick pipe) are squat in shape with bicone bowls.

The modern Basuto, if Christianised, has given up the use of dagga (*matckoma*) and the stone pipe, *ntsoana* or *kakana* (the clay pipe is similarly named). Tobacco is called *koae*.

Among the Naron of the Kalahari (19) the water pipe is not unknown, though they do not make it or use it themselves as do their southern neighbours. All adult Bushmen to-day smoke tobacco or dagga. Most of their trade is with other races, or service is undertaken with them for smoking material as remuneration. Smoking is suggested by Bleek to be the occupation of a Bushman in a painting, who squats and holds a long object to his mouth. If this is so, it is the only recorded Bushman painting of this habit.

Among the Hill Damara dagga was cultivated for its young leaves and seeds, the Koodo horn water pipe with small clay bowl was used (11), fixed at right angles to the horn. The great source of wealth of the Damaras during the mid-nineteenth century was from tobacco growing. Among the Ovaherero tobacco was used in short clay pipes, without horn or water. There is no evidence available that suggests smoking was common in South-West Africa before the appearance of these people.

The balance of the available evidence is, then, in favour of smoking

and of pipes, having been introduced into Africa only after the introduction of tobacco and smoking into Europe during the sixteenth century.

Typology of Pipes.

The best-known African example of stone boring or perforating, a procedure essential to pipe manufacture, is the Bushman digging-stone, which, after being battered to a globe, egg, or other shape, was perforated by pecking with sharp stone chips, and reaming with the dolerite thermal flakes, so frequently found showing signs of this use in Bushman deposits (20). The method of boring these makeweights appears to have varied very little. The removal of the partition between the two cone-shaped boreholes was by chipping and chiselling with stone chips, and the resulting connection is of considerable diameter. In the boring of ostrich eggshell beads the reaming process was continued until the two reamed holes met. The perforation in Bantu potsherd whorls and those of the stone-building culture is similar and usually bicone. The reamed (irregular or elliptic outline of a hole at its mouth, eccentric to its narrower inner end, shows hand reaming rather than rotary boring) repair holes along the cracks in Bantu or Bushman pottery are usually unicone. The only recorded large example of bicone boring by rotary motion is in the mopani wood posts excavated at Maund Ruins, Zimbabwe (21). Boring or reaming was a mechanical method used slightly by the Bantu, and much more by the Bushmen. The Hottentot is not recorded as having made perforated digging-stones, though he would pick one up and use it as a mallet head (P.W.L.). There is no evidence that the Hottentot ever bored pots to repair them, and no fragment of true Hottentot pottery has ever been found bearing repair holes; he does not appear even to have bored ostrich eggshell beads, which were articles of Bushman manufacture, and an object of barter to the Bantu and others with whom he was in contact. The extension of the chiselling method to the narrow perforation of long objects appears to have been a development of late days when metal was available (22).

Type 1.—It is therefore of particular interest to record a stone pipe of superficial digging-stone appearance from Flaauwkraal, near Aliwal North, found by Mr. T. Smit of Telemachus Kop. The illustration (Plate I, figs. 6 and 7) shows that the two perforations are unequal in size and are deliberately made so. The smaller perforation has been made in the usual digging-stone method, the larger boring also was so commenced, but one-half of its depth shows the use of the chiselling method, and is deeply grooved and shows signs of use as a pipe. This corroborates Commandant Bowker's statement, in so far that stones having the superficial appearance of digging-stones were used as pipes.

Type 1 pipes, globular, Bushman in origin, are so far recorded in two areas, which are neighbours and within a limited area: Flaauwkraal, Aliwal North (Plate I, figs. 6 and 7), and the Tsomo area of the Transkei (10), and were probably all used on the ground or earth type of pipe.

Type 2.—The plain tubular "Bushman" pipe is found made in sandstone in South-West Africa, and in what is popularly called soapstone, from the Orange River to the Cape. In thirty-five Hottentot burials investigated by the writer (23) in Namaqualand, only one plain tubular pipe was found, in a grave which tradition said was that of a Hottentot chief of *circa* A.D. 1800. On the farm Moordenaar's Kraal, in the Garies district, are two distinct groups of graves, the result respectively of a fight and an epidemic. Tradition classes the one group as Bushman and the other as Hottentot. Only the former contain tubular pipes, and again local tradition, which is only two generations removed from the Bushman's period, states that the Bushman used only the slightly tapered, tubular, unornamented pipe. The date of fight and epidemic is placed locally at *circa* A.D. 1830. The depth of the bowl (full length) and its narrowness, ·9 to 1·3 cm., suggests strongly that metal not stone was used in shaping the bowl. In one example the mouthpiece is distinctly rotary bored and its perforation is of even diameter.

The plain tubular Bushman pipe, usually of small size, 4 cm. to 5 cm., 1·5 to 2 cm., is recorded from Little Namaqualand (Plate I, fig. 4); South-West Africa; Dedeben, Ķorannaberg, 10·2 cm. in length (K.); Wolvefontein, Barkly West, 7·6 cm. long (K. 815); a specimen from Gouritz River, Mossel Bay (K. 950), shows three styles of boring, has a bowl aperture of 2 cm., and is probably a link between this group and group 3 of Type 3. Another from Riverton (K. 1527) is of well-polished "soapstone," 8·2 cm. long, bowl 1·5 cm. diameter, mouth 0·7 cm. diameter. This type's distribution is over the North-Western Cape and the adjoining parts of South-West Africa.

Type 3.—The narrow bone pipe is used by the Hottentots of Little Namaqualand (P.W.L.) and is found also in the Kimberley area (K.). None is recorded as surviving in the Southern Cape area, otherwise its distribution is similar to that of Type 2. It is recorded by Stow as being in use among the Bushmen.

Type 4.—The writer saw modern Hottentot pipe manufacture in Little Namaqualand during 1911. The pipe with the bowl at an angle to the stem is called *P/Koos* and is the man's pipe. The straight tubular pipe, P/ko D/oeis, is the woman's pipe (P/, palatal click; D/, dental click), smoked by holding the mouthpiece in the closed hand at the little finger side, and drawing the smoke through the closed hand in the manner that a Hindoo smokes a cheroot. An old Hottentot remarked that the size

of the bowl was regulated by the desire of the smoker and that a few used a reed or bone mouthpiece attached to the stone bowl.

No ornamented pipe bowl has ever been found in Namaqualand, except among these modern products. The modern tubular Hottentot pipe is longer than the Bushman pipe, and is sometimes provided with a ring at the mouthpiece, as in text-fig. ii, No. 3, whereas the Bushman's is usually plain tapered.

This type is limited in its distribution to Little Namaqualand and its neighbourhood. A tapered pipe was found at Riverton (K.) of soapstone, with ringed mouthpiece, tapered, decorated with suspended triangles on a band a quarter of an inch deep; and another (K. 1769) at Prieska, of soapstone, 7·2 cm. long, bowl 1·5 cm. diameter, with neck, boring at mouthpiece is eccentric, and around the bowl is a series of fine columns of chevrons. A white "soapstone" pipe from Herbert (K.) is 6·4 cm. long, and bowl of 1·5 cm. diameter, is tapered to a ring at mouthpiece, and around the broad end of the bowl is a pattern of three horizontal lines, the top space filled with diagonal lines falling to the left, and below with diagonal lines falling to the right, a pattern that may be Bantu or Hottentot in origin (28), and the presence of this ornamentation separates it from the earlier members of Type 4, but not from the later.

Type 5.—Pipes of the tubular variety, thick and long, with ornamentation varying from roughly incised patterns to intricate relief carving are two distinct extremes in what cannot be treated otherwise than as a single class, in which the more crudely ornamented approximate to the Bushman tubular pipe, Type 2, and the larger, to the Bantu cylindrical pipe, Type 8. There is a third group, of earthenware, which also is connected with this type by its method of ornamentation. This type will, therefore, be considered in three groups.

Type 5, *group* 1.—Portions of two short tubular pipes of agalmatolite (possibly a link with the tapered of Types 2 and 4?), roughly ornamented with incised lines which bring them within this type, were found at Heilbron (24), lying loose on the surface of a stone-building culture unit of enclosures (Plate I, fig. 9, B and C). A small tapered tubular pipe (K.) from the Langebergen is 5·1 cm. long, tapered, scraped longitudinally externally, and is ornamented in a manner suggesting Bantu origin.

Type 5, *group* 2.—As few of the large ornamented tubular pipes have survived intact, a description of the outstanding specimens will be given in detail. They form the most striking and distinctive of all the types. The majority are tapered only slightly towards the stem end.

Professor Maingard's specimen was procured, I am informed, in the Western Kalahari. A cast is in W.W.R.M.S., from which this description is taken. It is 22·25 cm. long, 5·5 cm. at thickest, 3·6 at narrowest.

Apertures are 3·4 and 2·2 cm. diameter. The original is of sandstone.

Stow (8) illustrates a perfect tubular stone pipe slightly tapered at both ends, and ascribes it to the Bushmen. It is presumably that specimen mentioned by him as in the possession of a Basuto, and its probable place of origin is the Eastern Free State. It is about 15 cm. long and 5 cm. at its greatest diameter, and ornamented with four bands of a close meander pattern.

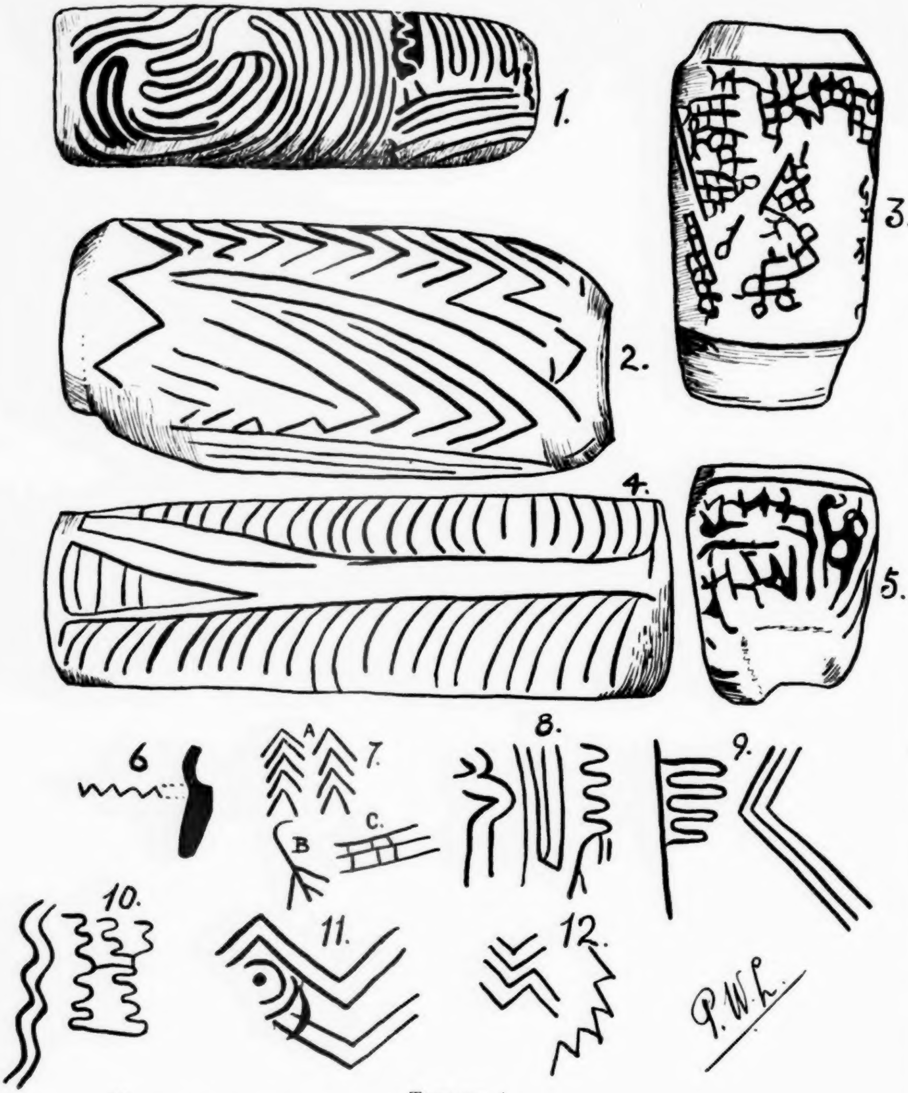
Several have been found in the Potchefstroom area. One from the Losberg in that district (W.W.R.M.S. 1046) is fragmentary and tubular, its greatest surviving length 6·9 cm., and diameter 3·5 cm. The stone shows signs of hand grinding to shape and scraping. It was bored by the chiselling method, and the partition was about 1·5 cm. deep. It is ornamented with a column of reversed chevrons, the lower ones of which become a line dancetté, or three-line right stagger, and to the right a line dancetté. This pattern suggests a closer connection with the west than with any other direction, as also dc the casts of other specimens from this district (W.W.R.M.S. 1047) found in stone-building culture settlements fifteen miles south-east of Potchefstroom. There are three specimens, all tubular: one ornamented with a sinuous raised pattern, the second with a broken column of lines dancetté, combined with an eye pattern (text-fig. i, No. 11), and the third with a horizontal herring-bone pattern (text-fig. i, No. 12). Other sites on which they have been found are Buyspoort, near the Bechuanaland border (31), at Struan, near Zeerust, where a section of tubular pipe of small diameter, well ornamented with incised chevrons in parallel, around the bowl, was ploughed up in a field near an ancient Bahurutsi stronghold.

Portion of a pipe of this type with an intricate design in high relief, and of larger size, was found in the ash midden of late examples of the stone-building culture erections at Schoongezicht, Transvaal (Plate I, fig. 9, A).

Another, complete, from the same place, is stated to be in the Potchefstroom Museum. Another from the Bethlehem area is in the Bloemfontein Museum; and one from Verkykers Kop, Harrismith, in W.W.R.M.S.

A portion of a pipe (W.W.R.M.S. 202), from an ancient site near Heilbron, is figured by van Riet Lowe (27) in his paper on the stone huts of Vechtkop, and is there described as being made of clay. It is of agalmatolite, and was originally a tubular pipe of over 6 cm. in diameter, and has a pattern in high relief.

Another specimen from this area is in Mr. N. L. Murray's collection (W.W.R.M.S. 1076), also in agalmatolite, 10 cm. long, 3·9 and 3·3 cm. diameter at its two ends, with bowl apertures of 2·2 and 1·8 cm. The



NO. TEXT-FIG. i.

1. Type 5, group 2, from Buyspoort.
2. Bethlehem, farm Uitvlugt (B), after van Hoepen.
3. Stone pipe, farm L.F., Bethlehem, after van Hoepen.
4. Buyspoort, type 5, group 2.
5. Type 5, Drakenstein, near Bethlehem.

Patterns on pipes.

6. (W.W.R.M.S. 1089.)
7. Vechtkop. A double column of chevrons A, the figure B is between two areas of C. (W.W.R.M.S. 1076), Type 5, group 2.
8. On a pipe of Type 5, group 2, from near Heilbron (W.W.R.M.S. 202).
9. Type 5, group 2.
10. Somewhat similar to No. 9, but from O.F.S. Mr. Murray's collection (W.W.R.M.S.), Type 5, group 2.
11. Type 5, group 2, from Potchefstroom (W.W.R.M.S. 1047).
12. Type 5, group 2, from Potchefstroom (W.W.R.M.S. 1046).

perforation is hour-glass with a chiselled-away connecting partition. The deeper bowl shows the staining of use. The pattern is a double column of incised chevrons.

The Bloemfontein Museum possesses several specimens from the Bethlehem district, O.F.S. One of stone (28), found in the neighbourhood of undescribed stone kraals in the Bethlehem district, farm Drakenstein (text-fig. i, No. 5), has an irregular incised pattern between two grooves. Another is recorded (26) and described further (28, p. 29) from the farm Susanna of the same district, also found in the neighbourhood of, but not in close or direct association with, stone-built enclosures (Plate I, fig. 12). The ornamentation is curved lines in relief. The reversed "E"-shaped portion, shown on the accompanying plate, is stated to represent a snake. It is also claimed that the pattern on the Vechtkop specimen described above (W.W.R.M.S. 202, and incorrectly described as of clay) is also a snake. Van Hoepen attributes his specimen to the Banoga, a small tribe with a snake siboko living near Lichtenburg, of which there is a branch near Potchefstroom. Both are somewhat far removed from Vechtkop.

The fine specimen (text-fig. i, No. 4) from Buyspoort described by van Hoepen (29, p. 38) is 14 cm. long, 4·3 at its broadest. The blank area in the pattern is described as a crocodile, a siboko figure, and therefore attributable to the Bakwana.

From the same district, farm Uitvlugt (29, p. 42,), came a fine sandstone pipe, illustrated in text-fig. i, No. 2. It is 12·7 cm. long and 6 cm. in greatest diameter. The columns of chevrons and staggered lines is essentially a Basuto pattern, and also suggestive of the Bantu-Bush contact. An undecorated stone pipe 7·3 cm. long and 4·8 cm. thick came from the same place.

From the farm "L.F.," Bethlehem district, came a pipe in hard sandstone, bevelled above, necked below, its greatest length 8·9 cm., greatest diameter 4·7 cm., and diameter at neck or stem 3·2 cm. It is decorated (text-fig. i, No. 3) with a fine network of grooves contained within very distinct triangles. This decoration is described by its recorder (29) as a conventional representation of the wild vine, a vegetable siboko, and he therefore ascribes this and another pipe (text-fig. i, Nos. 3 and 5 respectively) to the "Bamorara, a Basuto or Baquena people, who lived in the environment of Bethlehem." The latter, a short, tapered cylinder, with bicone bowl, from the farm Drakenstein, Bethlehem district, O.F.S. (28, p. 28), is of fine sandstone, 4·1 cm. long, its pattern is bordered above by a groove, and there is a slight bevel. It possesses characteristics, therefore, of the Type 5 pipe and also of the more modern Type 8.

Groups 1 and 2 of this type have a very limited distribution over the

Northern and Eastern Free State and the Southern Transvaal. Patterns are protean, so far no two similar patterns have been found; taper is uncertain; bevel occurs, as does narrowing at the stem, or neck, only rarely.

Type 5, *group* 3.—This group is made of earthenware, of shape approximating the smaller shorter cylindrical pipes of group 2. It is represented by the earthenware pipe from farm "L.F.," near Bethlehem (29, p. 44), which is undecorated, 4·9 cm. long, 4·7 broad, with a slight neck of 3·7 cm. diameter.

Type 6.—Earthenware or clay pipes, of smaller size than the preceding Type 5, usually undecorated, are usually somewhat irregular in shape, with bicone bowls linked by a perforation, and they lack distinctive characteristics. One from the Hartley district, Southern Rhodesia (W.W.R.M.S. 1118), is 4·8 cm. high, 3·1 diameter at the top, and 2·6 cm. below. The upper bowl has a tapered wall and the lower is squared off at the lip, their wall thickness is 0·45 and 0·6 cm. respectively. The two cone-shaped bowls are joined by a tubular link, which, with the decorated zone of short vertical incised lines, was made before firing. The whole is slightly necked. Such earthenware pipes with bicone bowls are frequently found on the stone-building culture sites in the Transvaal and Orange Free State (3), associated with pottery of Bantu appearance, and in all these specimens their state is such that it suggests moulding and burnishing, followed by firing, as in pot making, previous to use as pipes. The detail of one from Doornspruit, Magaliesberg, Transvaal (W.W.R.M.S. 1122, and figured in 3), is: irregular in shape, about 6·9 cm. high, tapered walls, diameter of top bowl 4·7 cm., of lower 3·4 cm.; walls 0·7 to 1 cm. thick, moulded, and the bowls joined before burning. The upper and larger bowl shows signs of use as a pipe.

A number of undecorated earthenware bicone pipes have been found at Tinley Manor, Natal. They are 2·5 cm. to 5·1 cm. in length and are associated with late Bantu ceramic material. A specimen (W.W.R.M.S. 1189) from near Balgowan, Natal, has a well-burnished surface, suggestive of Bantu ceramic method. Its fragmentary state makes it difficult to describe, but it was probably originally globular in form, which is uncommon. It is 4·9 cm. in diameter, with walls 1·4 cm. thick, and tapered to the lip. It shows signs of use as a pipe.

This type is rare south of this area, and the few recorded come from Bushman shelters. One from Burnt Kraal, near Grahamstown (A., and 30), is a small rough cone pierced longitudinally, and was found superficially in a Wilton association. One from a cave in the Bethal district (W.W.R.M.S. 302) is slightly necked, and therefore more probably of Bantu origin. It is 6·0 cm. high, 4·2 cm. in diameter at the top, 3·0 below,

the bowls are hour-glass, 3 cm. and 1·7 cm. deep respectively, with a tubular-pierced link. The outer surface is rough and only slightly burnished, the walls are tapered, and the larger bowl shows distinct signs of use as a pipe.

The distribution of this type appears to be chiefly Eastern Free State, and the adjoining province of Natal, with an outlier in the Eastern Cape.

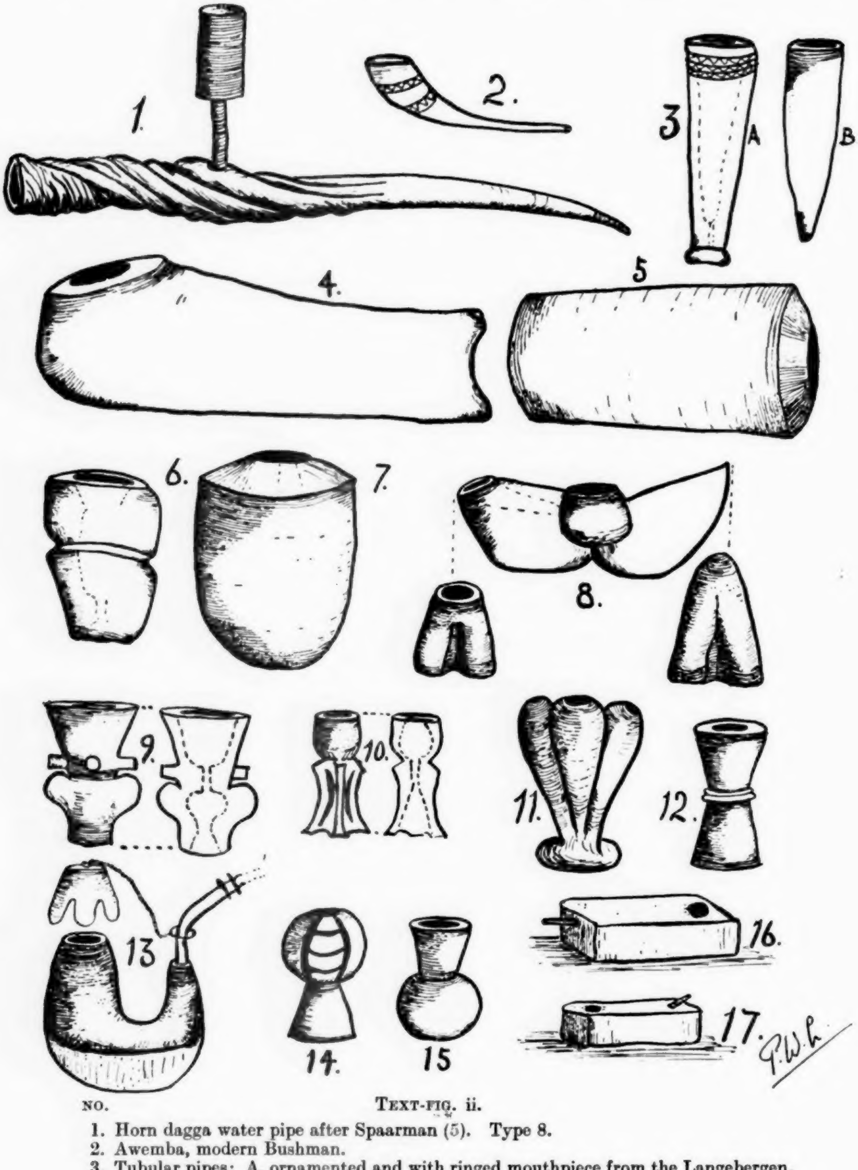
Type 7.—Multi-bowled Pipes.—The term is here restricted to those pipes each of which possesses several bowls, in each of which the material to be smoked was placed.

A soapstone pipe of unusual shape and design is represented in the W.W.R.M.S. collection by a cast, it is shown diagramatically in text-fig. ii, No. 11. It is 13·5 cm. high, 10·6 across the broadest part of the three bowls, and 4·6 diameter at its circular ring base. Each bowl is 4·6 cm. in greatest diameter outside, and within are irregular and hollowed or concave, and vary from 2·1 to 2·5 cm. diameter. The bowls are placed at an angle to the base and lead to a single hole 2·1 cm. diameter. The concavity of the bowl walls and consequent narrowing at the mouth (as opposed to the usual conical shape) is an uncommon feature and found only in specimens attributable to recent times, Type 10. Multi-bowled pipes are not uncommon in the modern wooden metal-lined pipes of the Southern Bantu, Type 13.

Type 8.—Cylindrical Stone Pipes.—Smooth finished, bevelled, for use with the water horn, considering the number that must have been made by Bantu people in the past, are rarely found in museums. One in red sandstone, 6·1 cm. by 5 cm., was found on Signal Hill, East London (P.W.L.), which cannot be older than the first Bantu migration into those parts. Another, five inches long, and two and a half in diameter, was found at Brakkloof, near Grahamstown.

An unusual specimen, irregular in shape, and with a groove around it, in a fine, hard, dark stone, was found in a cave near Harrismith (Bloemfontein, H. 2674), associated with Bantu pottery of the late stone-building culture (text-fig. ii, No. 6), may be classed in this type or under Type 5, group 2, undecorated.

An original Basuto specimen, complete with horn, is preserved in the small museum in the Council building at Maseru. Its bowl is slightly tapered, 7·6 cm. long, 4·4 cm. at its widest, and is slightly and regularly bevelled at the upper end. Specimens (without horn) have been procured by the writer in Basutoland of similar design, though of larger dimensions. The bevel is distinctive. The finish is smooth and regular. The bowls are broad and with a tubular link. A larger specimen, broader, but equal in finish, and possessing this distinctive bevel, was found at Struan, near Zeerust, in the vicinity of an ancient Bahurutsi stronghold. It has for



NO. TEXT-FIG. ii.

1. Horn dagga water pipe after Spaarman (5). Type 8.
2. Awemba, modern Bushman.
3. Tubular pipes: A, ornamented and with ringed mouthpiece from the Langebergen, Type 4; B, plain-tapered Bushman pipe, Type 2; both soapstone.

years been accepted by its owner, Captain Robertson, as a "digging-stone," but the large size of the aperture, the small tubular link, the design of large bowl opposing a small bowl, all point to its being a pipe of this particular type. It is 15·3 cm. high and 10·2 cm. in diameter, and is represented here in text-fig. ii, No. 7.

This type of pipe was in use among the Southern Bantu on the Kaffrarian coast, the Basuto of Basutoland until recently, the Bechuana, the Bahurutsi (Chief Manyani), and Ovambo. This type is illustrated by Spaarman (5) in his Plate I as Bushman. It is widely distributed within the limits of Bantu migration *circa* A.D. 1750 to modern times, and outside the limits of distribution of Type 5.

Type 9.—The brick type of pipe, of plaster or clay of brick form, hollowed to hold water, with bowl moulded in upper surface at one end and with a mouthpiece inserted at other.

District in which found or recorded: Prieska, of cement, with bone mouthpiece (P.W.L.), now in the Hunterian Museum, Glasgow. All Hottentot specimens include a bone mouthpiece. This may be classed as the western section of this type; Basutoland, of well-built clay, "dagga pipe" (M.), 11·6 cm. long, 4 cm. at highest, 3 cm. at broadest, and 2·5 cm. at narrowest, is illustrated in text-fig. ii, No. 4. This may be called the eastern section of this type.

A border-line specimen, without a water reservoir, in "soapstone," was found in the Schagen Valley, Eastern Transvaal (W.W.R.M.S.) (text-fig. ii, No. 8). It is carved out of an oblong piece of stone. Its maximum length is 11·4 cm., height 6·1 cm., breadth 4·5 cm. Its shape is suggestive

4. Basuto brick dagga pipe (M.), 11·6 cm. long. Type 9, east.
5. Basuto cylindrical dagga pipe (P.W.L.). Type 8.
6. Harrismith. Grooved (B. H2674), Bantu. A link between Type 5 and 8.
7. A development of the cylindrical pipe, with similar, bevelled mouth, but of digging-stone size, 6 by 4 inches, well finished with large and small bowls, from Struan, near Zeerust. Type 8.
8. Pipe from Schagen Valley, Transvaal (W.W.R.M.S.). Side and end elevations to show tentative animal shape. Total length 11·4 cm. Greatest height 6·1 cm. Unique. Has affinities with the Arab North.
9. From White River, Transvaal (W.W.R.M.S. 3951), and section to show lower hollowed bowl. Height 5·1 cm.; diameter, top 3·2, base 2·5. Type 10.
10. Shows overhung walls; 5·4 cm. high, 3·3 diameter base (W.W.R.M.S. 1088). Also Type 10.
11. Carved soapstone three-bowled pipe, from Kalahari (W.W.R.M.S.). Height 13·5 cm. Greatest diameter 10·6, diameter of base 4·6 cm. All bowls connected with single stem hole. Type 7.
12. Modern Matabele (A.), soapstone. Type 10.
13. South African-European, wood bowl, Cape silver ground, and horn mouthpiece (J.M.A.M.). Soapstone pipes found at Qumbu in Transkei (A.) have similarly flanged bowls. Type 11.
14. Modern Matabele. 2½ inches diameter (P.E.). Type 10.
15. Modern Zulu. Type 10.
16. Brick Pipe. Locality?. Cement and clay (P.E.). Type 9.
17. Cement brick pipe. Prieska. Bone mouthpiece (P.W.L.). Type 9.

of an uncompleted attempt at animal representation. Though its base suggests that it was intended to rest on the ground, the angle of the smoke hole or stem precludes it from inclusion in Type 12, and its primitive finish, with smoke hole entering the bowl in its middle, excludes it from Type 11.

This type of pipe has been used by Hottentots in modern times, and by coloured people and Bantu. It is an adaptation of the ground type of water pipe. When a bone mouthpiece is used, this distinguishes the specimen as being of Hottentot origin. Its distribution is very limited in area, and in spite of the similarity between eastern and western sections of the type there appears to be a gap between them. It is probable that they are of independent invention.

Type 10.—Cylindrical pipes, highly ornamented, carved into symmetrical and complicated designs, of which there are numerous specimens of known recent Mashona origin (A.). They are also recorded from Best Pan, Riverton (K. 150).

An unusual specimen was found at White River, between Nelspruit and Pilgrim's Rest, Eastern Transvaal (W.W.R.M.S. 3951), of white marble-like "soapstone." Its height is 5·1 cm., diameter of top bowl 3·2 cm., of lower 2·5 cm. It has been carefully carved out of a single cylindrical block, the upper bowl is cone-shaped, with at its lower diameter four cylindrical projections. The upper and lower bowls are joined by a tubular link, and the lower bowl has been hollowed so that its inner portion is bulbous and of greater diameter than the aperture (text-fig. ii, No. 9). In appearance it has similarities with the modern Matabele pipes, and with a large specimen from Swaziland (B.A.).

A particularly beautiful green "soapstone" pipe (W.W.R.M.S. 1088) comes from Schagen Valley, Transvaal. It is highly polished and its design is on unique lines (text-fig. ii, No. 10), a series of four pillars support the bowl, carved out of the solid cylinder. It is 5·4 cm. high, the pillars are 3·2 cm. high, and the greatest diameter of the bowl 3·2 cm., its aperture 1·7, which increases inside. The base is 3·3 cm. diameter, and at the valley of the pillars is 2·4 cm. in diameter.

A fragment from the same locality (W.W.R.M.S. 1089) of soft micaceous "soapstone" is plainer, and the bowl is distinct from the stem. It also has a bulbous bowl, which widens towards the tubular link with the lower bowl. At the neck it is ornamented with a line dancetté.

An unfinished cylindrical pipe from Schagen Valley (W.W.R.M.S. 1108) shows pecked and battered ends, and one slightly polished side; at the broader end pecking has been commenced to make the bowl. It is 5·1 cm. high, 4·7 in greatest diameter, and 3·5 at least, *i.e.* a slightly tapered cylinder.

A rough earthenware pipe from Schagen Valley (W.W.R.M.S. 1090), with small bowl 1·2 cm. diameter, with walls 0·6 cm. thick, unfortunately fragmentary, is classed under this type, because of its shape and mamillated ornamentation.

Two dagga pipes of soapstone were found in a little debris heap outside the southern entrance to Nanatali. Among the objects found at Khami are carved stone pipes. Two i'daha pipes, "old Makalanga," of "soapstone," came from enclosure V of the Elliptical Enclosure, Zimbabwe, during 1902–03. A quotation of this list of Hall's is the only mention made by Caton-Thompson in "Zimbabwe Culture" of pipes, and that investigator found none during her investigations. Randall MacIver (32) also states that these pipes were used for dagga smoking.

These squat, finely designed and executed smoking pipes have been found *only on the surface*, and none was found during investigation of early stone-walled structures in Bechuanaland by the writer. The modern Matabele, Mashona, and Basuto carved soapstone pipes are all similar. The distribution of this type is Southern Rhodesia, Northern and Eastern Transvaal. An odd specimen has been found as far south as the Free State, near Heilbron (Plate I, fig. 8), and is in Mr. Lomax's collection, and similar occur in Zululand. All are of recent age, and none occur in close association with the earlier phases of the stone-building culture.

Type 11.—Angled or curved pipes of the European period.

In certain museums are soapstone pipes which vary from elaborate to simple construction; many of which show fitments, such as metal bowl covers, which are known to be of European origin (33), and usually they are fitted with turned horn stems of distinctive and similar design.

That shown in text-fig. ii, No. 13, is carved out of wood (J.M.M.). It has the usual multi-flanged stem, and is provided with ring, chain, and bowl cover in silver of Cape Town manufacture. It is claimed to be a South African pipe of European manufacture dating *circa* 1830. Its particular interest is that its form is similar to that of a number of pipes (A.) of soapstone found in Griqualand West and the Transkei near Qumbu and Indwe, bowl and stem being parallel, with a semicircular connecting flange beneath.

A stemmed pipe, with stem at right angles to the bowl, was found in the Rustenberg district (W.W.R.M.S. 1204). It is made in a greenish veined stone, and has a tendency to a ridge or flange beneath junction of bowl and stem. The bowl has been bored in a rotary manner, and has a small depression at its base, into which the narrow-bored stem hole enters. It is the nearest approach to the modern European pipe of all described. The stem hole is 0·3 cm. diameter.

Another rotary-bored stone specimen was found on the surface at

Wolmaranstad, Transvaal (B : H. 2918). It is small, 3·9 cm. by 4·4 cm. overall, and has a ring of stone left at the base. Here and there on its surface are criss-cross scratchings. The stone of which it is made, soft diabase, is stated not to occur in that district.

In the East London Museum is a pipe of South African soapstone, fitted with silver cap and wooden mouthpiece, an heirloom of an old Cape family, who traditionally regard it as "Huguenot" (Plate I, fig. 14). In the South African Museum is the bowl of a similar pipe found in a well at Carnarvon, C.P., which has been broken and carefully repaired (Plate I, fig. 14) by boring fine regular holes around the edge and casting common solder over it to replace the lost portion. That such pipes were used by Europeans in the Colony's early days is suggested by the item "stone pipes" in the inventory of Dr. Akkerman of Cape Town (34), and the references to pipe working in Louis Trigardt's diary (35 : 1836–38). Dr. Preller in his footnote refers the mention "het Carolus aan de peijpe gewerkt" to the working of soapstone by saw and knife.

In the Albany Museum (Plate I, fig. 11) is a pipe of complicated design of a bird on a flat broad base, for table use, with silver fittings, which also appear to be of European use if not of manufacture. A fragmentary specimen (K. 1462) from north-west of Koffiefontein of fine green stone, flat based, octagonal, appears to be worked with metal. Another (K. 1399), also from Koffiefontein, is in imitation of the European style, or is of South African-European origin and workmanship. Altogether, the indications that there was a trade in carved soft stone pipes, made for and sometimes by Europeans, are strong; their distribution is wide, their design frequently complicated and well executed, and there is an essential similarity in the silver fittings and the horn mouthpiece. The writer has another specimen, in which the wooden mouthpiece is linked to the stone bowl by a short length of hide thong.

Type 12.—A small selection of interesting pipes brought back by Dr. Galloway from East Africa (W.W.R.M.S. 1073) are worthy of description as representing a distinct type which did not reach South Africa unchanged, the Arab type. Their distinctive feature is the use of a long wood or reed stem with a small bowl, which results in, or necessitates, a flattish area at junction of bowl and stem on which the pipe is rested, and the position of which shows that in action the pipe was not used with its stem horizontal but with a long added stem at an angle, so necessitating a slightly flattened base, with stem and bowl at an angle of forty-five degrees to it.

Type 13.—Modern native pipes of known origin are mostly made in wood, and are protean in shape, size and design, and ornamentation. In these modern pipes the native shows his innate ingenuity and artistry. Drawing on the pipe causes a cleverly arranged wheel on the stem to

rotate; on cessation of drawing allows smoke to curl up from the funnel of an engine drawing a train, tender and train forming the stem. In clay the hat of a man on horseback forms the bowl. The stem is long and forms an acute angle with the bowl in the usual native pipe, but there is now a tendency to imitate the European right-angled form.

Discussion.

The existence of smoking among Bushmen previous to the appearance of European or Bantu is supported neither by eye-witness accounts nor by archaeological evidence in Bushman caves. No Bushman deposit earlier than the most recent has, in the Cape, produced pipes. No pipe has been found by the writer in any Wilton deposit, or on, or in, any shell-mound on the Namaqualand coast, or in direct association with any shell mound on the Eastern Province coast.

The Hottentot (Little Namaqualand) angled pipe, Type 4, developed directly from the European angled pipe used by the Dutch at the Cape during the seventeenth century, and unfinished specimens recovered (P.W.L.) show that they were worked with metal tools. Of the clay pipes introduced by the Dutch at that time, and so freely given to Hottentots, only one so far has been recovered, though this distribution in the south probably explains the limitation of Type 4 to Little Namaqualand.

The European, Type 11, waterless pipe, spread northward from the south after its introduction by the Dutch, and ended in a combined European-Native manufacture of and trade in stone pipe bowls and pipes for European, Hottentot, and Griqua use. Those of Namaqualand, always isolated, developed along independent lines. There is no evidence forthcoming to support the statement that the Hottentots of Little Namaqualand used a reed or wood mouthpiece, or even used the water pipe. The plainness of the earlier type is distinctive and localised in distribution, and they are free from mouth stops or rings. In the Cape doubtless the industry was European, in the east and north-east it is known that Europeans of the period of the trek made stone pipes, and the Pondoland specimens represent this also, or manufacture by Griquas under European direction.

Stow ascribed Type 5 pipe to Bushman exclusively, while Van Hoepen equally exclusively ascribes them to Bantu. The Bantu reached the Pondoland coast *circa* 1750, and the Tsomo area was not occupied by them until *circa* 1840. The Flaauwkraal area was inhabited by Bushmen within living memory; Type 1 is then probably late and imitative, and the result of Bushman notice of Type 8 pipe in use on the coastal area after the appearance of the Bantu, *i.e.* during the eighteenth century.

In the distribution area of Type 5, Bushmen came into contact with and were absorbed by Bantu of the stone-building culture, and in at least one colony became isolated, and resulted in a hybrid race (24). In no instance in a purely Bushman association has such a pipe been found. In no instance has a pipe of this type been found in stratigraphical position to suggest an age of over a hundred to two hundred years.

The only ascription of a pipe to a Stone Age period is that of Burkitt (36, text-fig. xvi, No. 4), who equates a Type 8 stone pipe, "a pierced stone" of 2 by 2 inches, found at De Kiel Oost on an open Smithfield site, to, it appears, the lower section of that period. This is a mixed Smithfield A. and B. site. There is no evidence to suggest other than that it belongs to the latest phase, which falls within the European period.

The patterning and ringing of the mouthpiece of the later mode apparently links up the modern Hottentot along the Orange River with the Herbert and other specimens in the Kimberley Museum, and the specimen described by Heese from Hopetown (37) and also has affinities with the Griqualand modern stone pipes. Many of Types 4, 5, and 8 show evidence of being worked with metal tools. There is accumulating evidence to suggest that all such narrow perforations in implements of presumed Bushman origin, became possible only after the introduction of metallurgical processes and the use of metals into South Africa (22), and that its application was imitative.

The use of water in any brick, horn or stone pipe, and the use of a wooden mouthpiece in South Africa is suggestive of development from Bantu contact in the north, and again with them, from Arab contacts, to the north-east. That such a filtering through of the idea, in an indirect manner is possible, is supported by the early bead trade, though this trade reached the Hottentots of Little Namaqualand, the water-pipe idea did not.

The brick-shaped water pipe, Type 9, was used by the Eastern Orange River Hottentots, with a bone mouthpiece, reminiscent of the earlier use of marrowbone as a tubular pipe for dagga smoking, which was called P/Ngaies (*i.e.* palatal click). This type is restricted to an area along the Orange River, Prieska, and Basutoland. The water-pipe types developed in the north, and spread southward. The sub-types are the result of tribal artistry and period.

The distribution of pipe types shows that there are limitations to each type. The horn-reed stone-bowl water pipe was universal among Bantu, and its distribution is from the north and over the north-eastern portions of the Union. The cylindrical bowl found on Signal Hill, East London (P.W.L.), represents the far southern limit of the type.

Type 10 pipes are an artistic advance upon the plain tubular Type 8

and are limited in distribution, being more common in Southern Rhodesia. They appear also in the Transvaal and are represented in the Free State by a single specimen. In chronological order, Type 5 probably comes before certain of the Free State specimens (text-fig. i, Nos. 3 and 5), which again precede the modern plain cylindrical Type 8. All are probably Bantu in origin; Type 5, group 1, probably represents a Bantu-Bush contact, and the other sub-groups tribal independent effort.

Pipes have, therefore, some value as dating objects, and their typology may suggest tribal migration and tribal or racial contacts.

One word of warning must be included. Thompson (7, Plate (facing page 307, vol. i), p. 303) illustrates an ivory whistle of the size and shape of Type 5 pipes, closed with a plug carved into semblance of a human head. There is, therefore, the possibility of carefully carved bone whistles being found, which must not be classed as pipes.

Acknowledgments.

To Professor Dart for his generous freedom of the Witwatersrand Medical School collection, to other museums, and especially to Dr. Gill of the South African Museum, for access to material; to Professor Stanley of the Witwatersrand University for an analysis of the metal used in repairing one pipe; to my son for the photography necessary to produce the plate; and to Miss D. Cumming for the typing, and my son for the photography, my thanks are recorded.

Dr. Rogers has provided the following note on the stone popularly called soapstone, which is acknowledged with thanks:—

"The rock from Namaqualand used for making pipes is not soapstone (hydrated silicate of magnesia). Alphonse Gages examined specimens brought to Dublin by Andrew Wyley in the late fifties of last century, and a paper by him, 'Analysis and Observations on some sedimentary Rocks from the Cape of Good Hope having the appearance of Serpentine,' is in vol. viii, pp. 171–172, of the Society's Journal, 1857–60. Gages found the rock to be chiefly a silicate of alumina with water and small quantities of iron, lime, magnesia, potash, and soda, saying, 'These rocks may be considered as belonging to that class of compounds called by such various names as Agalmatolite or Pagodite, Dysintribite, Parophite, etc.' In the course of the geological survey of the Union the rock has been examined in place and in the laboratory; it is an altered sillimanite rock occurring as thin bands in gneiss, and Gages' analysis gives a good notion of its composition. The name now used for such rocks is agalmatolite."

EXPLANATION OF PLATE.

FIGS.

1. Type 9 (S.A.M.).—Pipe from considerable depth found in well sinking, New Carnarvon. Repaired by boring and casting common solder to fill gap.

2–3. Type 4 or 11 (P.W.L.).—Angled pipe bowls, Little Namaqualand, unfinished, and showing use of metal tools, saws, and files.

4. Type 2.—Bushman pipe, Little Namaqualand (P.W.L.), 4·3 cm. long, outside diameters of bowl 1·5 cm. and 0·9 cm.

5. Rough block, metal worked, for small tubular pipe. Probably Hottentot (P.W.L.) early Type 4.

6–7. Type 1.—The upper and lower bowls of Flaauwkraal pipe (P.W.L.).

8. Type 10.—Ornamented tubular pipe. Heilbron district, O.F.S. Mr. Lomax of Heilbron.

9. Type 5, group 2.—(A) Schoongezicht, Transvaal; (B) and (C) Heilbron, Type 5, group 1 (P.W.L.).

10. Type 8.—Tubular Basuto dagga pipe (P.W.L.).

11. Type 11.—Soapstone pipe, intricate design, silver fittings and horn mouthpiece.

12. Type 5, group 2.—From tubular pipe. Photograph by favour of Dr. van Hoepen.

13. Two pipes in Albany Museum, labelled "Bakwena." The lower specimen is similar to the Hottentot angled pipe, and the upper has a distinctly German cast of bowl, with a horn mouthpiece typical of the European made stone pipes.

14. Type 11.—A soapstone pipe (E.L.), with Cape silver fittings and horn mouthpiece.

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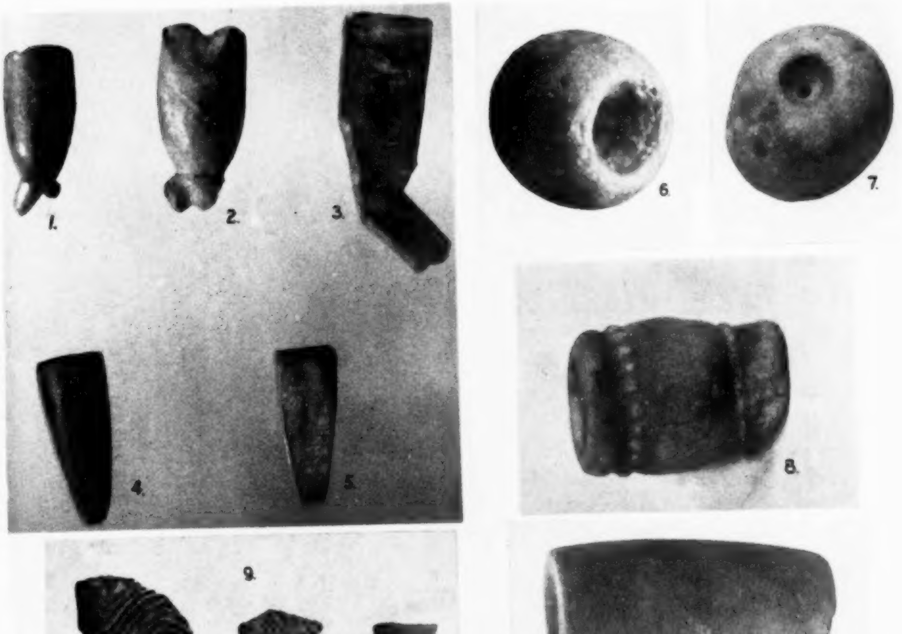

P. W. Laidler.

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THE TEETH OF THE SOUTH AFRICAN FOSSIL PIG (*NOTOCHOERUS CAPENSIS* SYN. *MEADOWSI*) AND THEIR GEOLOGICAL SIGNIFICANCE.

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(With six Text-figures.)

Introduction.

In 1925 (1) Broom described a large molar tooth which had been discovered in the diamond gravels of the Vaal River, near Longlands. This tooth resembles the molars of some of the extinct pigs of the Siwalik of India, and has also characters found in the third molars of the modern wart hog *Phacochoerus*. Broom concluded that the tooth was a lower third molar of an extinct giant pig which differed so markedly from either *Sus* or *Phacochoerus* as to warrant its being considered a new genus. For this new genus he proposed the name *Notochoerus*, while the species represented by the tooth he distinguished by the name *Notochoerus capensis*. Three years later, in 1928, the same writer reported upon another third molar of an extinct pig. This specimen also was found in the Vaal River valley, but, according to Broom (2), while "it agrees sufficiently with the molar of *Notochoerus capensis* to suggest the advisability of retaining it in the same genus, it certainly represents a very distinct species." This species Broom named *Notochoerus meadowsi*.

The present writer has recently discovered at the Sterkfontein Caves three more third molars of an extinct South African pig. As a result of investigation and comparison of the characters of the teeth with those of the two reported upon by Broom, it was found that they belonged to the same species of pig as that represented by the *N. meadowsi* tooth. This led to investigation of growth changes in third molars of the modern wart hog *P. africanus*. Such an investigation has been long overdue and will form the subject of another paper. Its importance here is that it has shown that the differences between old and young wart hog teeth are much greater than has been appreciated hitherto. Moreover, it has demonstrated that the differences between the *N. capensis* and *N. meadowsi* molars are of the same order as those between old and young molars of the living

type. In view of this, I have decided to describe the characters of the three teeth I have discovered, and I hope to show that only one species of fossil pig is represented by all of the five specimens hitherto discovered. Furthermore, as both the Vaal gravels and the Sterkfontein Caves are of great significance in unravelling the anthropological story of South Africa, I hope the present study will lead to a better understanding of the associated fossils from these deposits.

The Teeth Discovered by the Writer.

These teeth were discovered early in the present year at the Sterkfontein Lime Works, near Johannesburg, and, as previously stated, consist of three third molars of the *N. meadowsi* type. They present the same degree of fossilisation, and were found less than one foot apart in the same piece of rock. Associated with them in the rock were fragments of a skull and lower jaw and of a fourth third molar. Two of the complete molars belong to a lower jaw, one belonging to the right and the other to the left side of this jaw. The third tooth has the characters of an upper third molar, and in view of these facts, and as, in addition, the three teeth exhibit a corresponding degree of development, it is highly probable that they belonged to one animal.

Fig. 1 is a drawing of the three teeth. That they belong to a young animal is shown by the fact that their columns, except the most anterior pairs, are below the level of the masticatory surface and unworn. The lower molar A is the best preserved of the three specimens. It measures 79 mm. mesio-distally at its base; its greatest width at the same situation is 20 mm., and its height at the third inner cone is 68 mm. It presents seven pairs of side cones and twelve median cones, and on its anterior portion two roots were originally present. The buccal root, which was long and tapering and inclined distally, was broken in removing the specimen from the rock. The inner root also broke away when removing the specimen but was restored by means of wax. It is stoutly built and directed vertically downwards. Originally it must have measured about 25 mm., but the apex is now missing and only 13 mm. of root remains. The lower molar B is considerably damaged at its base. Its greatest mesio-distal length is 77 mm., its greatest width 20 mm., and its estimated original height at the third inner cusp 66 mm. It has six pairs of side cones and eleven median cones, and although roots are absent there is no doubt from the condition of the base that roots similar to those seen on the specimen A were present originally. The third specimen is damaged distally and at its base. By presenting a laterally protruding second outer cone, such as is seen on upper third molars of modern wart hogs, it shows it is a tooth from an

upper jaw. It is slightly less developed than the lower molars. A lesser degree of development of upper molars compared with lower molars of the same jaw is, however, the normal condition in the modern wart hog, and this character thus associates the tooth with the lower molars and confirms the view that the three teeth belong to one animal. The cones at the distal

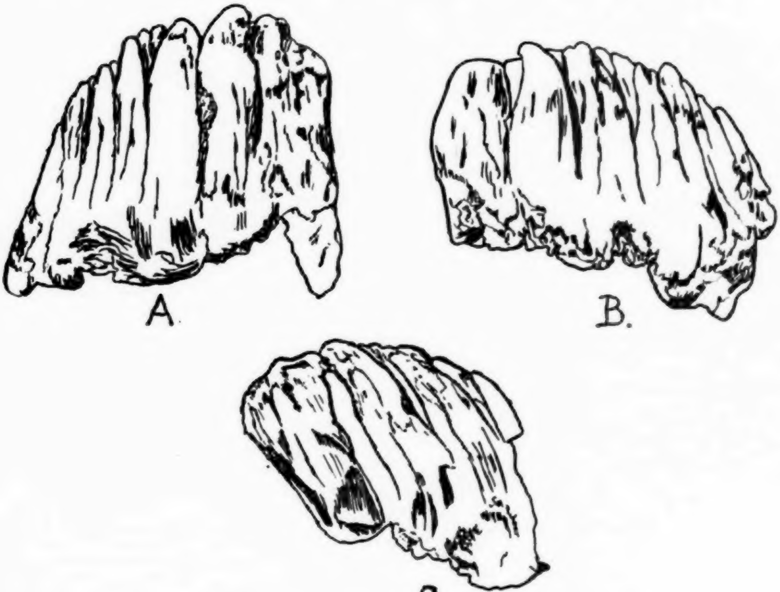

FIG. I.—The three teeth discovered at Sterkfontein. A and B are lower, and C is an upper third molar. About ⅔ natural size.

end of the tooth are bunched together, while on the outer surface of the third lateral side cones and between some of the side and median cones small "extra" cones are present. These characters make it difficult to determine the exact cone formula, but nevertheless it is possible to distinguish six pairs of side cones, ten median cones, and four "extra" cones. As in the specimen B, roots were originally present but are absent from the tooth as preserved. The length of the tooth (measured through the centre line due to damage at the basal distal end) is 62 mm., and its width at its base 30 mm. It is estimated that the original height of the tooth was 60 mm.

Although very much larger in size, anatomically these three molars

FIG. 2.—To illustrate five odontogenetic stages in the development of third molars of the modern wart hog *P. africanus.*

Note.—As sufficient upper or lower molars were not available, teeth from both jaws are utilised in the illustration. The specimens A, B, and C are lower left third molars, the specimen D is a lower right third molar, while the specimen E is an upper right third molar.

resemble the corresponding teeth of the modern wart hog. Their mode of development must therefore also have been similar to that seen in the living animal.

Fig. 2 illustrates five stages in the development of the third molars of the wart hog. All the teeth are similarly oriented, the anterior margins being to the left side in each tooth. The specimens A to E represent every necessary stage from early youth (A) to senile old age (E). The youth of the tooth marked A is shown by the fact that its distal columns are below the level of the masticatory surface and unworn. In the tooth B all except the most distal pair of columns have reached the masticatory surface and are worn, while the occlusal surface of the tooth is longer mesio-distally than in the former specimen. In the tooth C all the columns have reached the masticatory surface, and in addition we now find that root development has commenced at the base of the anterior columns of the tooth. In the tooth D root development has progressed to the extent that long roots are present on the anterior columns and these are closed at their apices, while short partially closed roots are present on the remaining more posterior columns. At this stage the anterior columns have become exceedingly short in the vertical direction due to attrition at their occlusal ends and lack of deposition of fresh calcific matter at their base—a consequence of closure of the roots. The more distal columns are also shortening. The specimen E belongs to an old animal, and in it the anterior columns and roots have disappeared, due to continued attrition at the occlusal surface, and the tooth has become exceedingly short mesio-distally. In addition it has decreased in height due to the remaining columns having developed closed roots, thereby terminating the growth of the columns.

The columns of the fossil teeth (fig. 1) present a degree of development corresponding to that seen in the modern molar A in fig. 2, but in root development the condition exhibited corresponds to that seen in the tooth D in the same figure. Van Hoepen (3) has shown, however, that late development of roots, such as is seen in the modern wart hog and was still more evident in the recently existing hog *P. aethiopecus*, is a specialised character. The early development of roots on the fossil teeth must therefore be explained as a primitive character, and although this character must have resulted in the fossil teeth attaining their full development sooner than occurs in the living wart hog, it could not have affected the stages through which the teeth passed in reaching that condition. With further development the teeth now discovered would therefore have presented a stage in which their anterior roots were closed and their anterior columns shortened, a later stage in which their more distal columns had developed roots and shortened, and a still later stage in which

their anterior roots and columns had broken away and the mesio-distal length and height of the teeth had decreased. Moreover, as attrition accompanies development the occlusal surface of the teeth would also have shown variations. As previously pointed out, only the anterior columns are worn on the specimens as discovered. At a later date wear would have been evident on all the columns, while continuation of wear would in time have resulted in a considerable portion of the occlusal ends of the existing columns being worn away. But as they approach the base the columns increase in size mesio-distally, and in addition they fuse with adjoining columns. If growth had proceeded, therefore, the columns shown on the occlusal surface would have been very much larger in size, more complex in

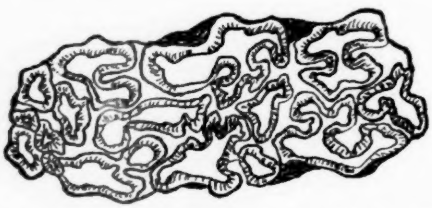

FIG. 3.—A section taken through the centre of the upper third molar found at Sterkfontein. To show how the columns increase in size, become complex in form, and decrease in number in the body of the tooth.

form, and considerably fewer in number than they are at present. This is clearly illustrated by a section taken through the upper molar (fig. 3). As previously pointed out (fig. 1), there are six pairs of side columns, ten median columns, and four "extra" columns on the existing occlusal surface of this tooth. Below this surface, however, as seen by sectioning, there are only four pairs of side cones, six median cones, and two extra columns. In other words, there is a marked reduction in the number of cones; but the cones now presented are of large size and complex form, and have obviously been derived from the fusion of a greater number of cones which, on the existing occlusal surface, are separate and distinct.

With further development and attrition, therefore, these fossil teeth would have presented a stage in which their anterior roots were closed and their anterior columns short, their posterior columns in the process of shortening, their posterior roots partially closed, and their occlusal surface presenting a relatively small number of large complex-shaped columns. Moreover, as the upper molar has a wide base, and as this in time would have become the occlusal surface (due to growth at the base and attrition at the occlusal surface), it must also be concluded that at the same stage this upper molar would have been wider than it is at present. In

fact its width would have been similar to the width of the present base, namely, 30 mm.

It is now necessary to consider the characters of the *N. capensis* and *N. meadowsi* teeth.

THE *N. capensis* TOOTH (fig. 4).

Broom's description of the characters of this tooth is exceedingly brief. He states it is a lower third molar and that its anterior portion is missing.

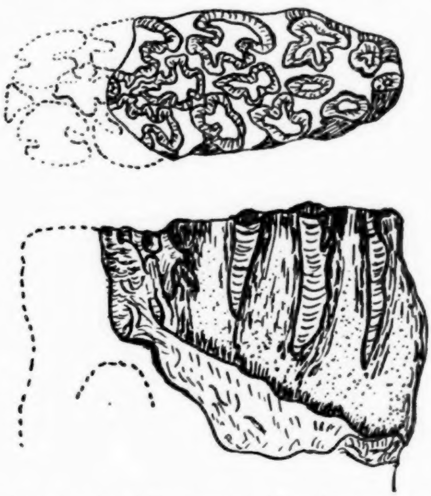

FIG. 4.—The third molar of *N. capensis*. About ⅝ natural size (after Broom).

The following measurements are provided: Greatest length of the specimen as preserved, 64 mm.; greatest width between the second pair of cusps, 30 mm.; height at the posterior cusps, 45 mm. He mentions five pairs of lateral cusps and six median cusps, and describes the median cusps as being "so large that they completely separate the lateral cusps from each other, as they also do in *Phacochoerus*." The anterior cusps he states "are much infolded as in *Sus*, but the posterior are simple rounded pillars as in *Phacochoerus*." He estimates that when perfect the tooth had a length of 79 mm., but fails to estimate the original height of the tooth, although the base as well as the anterior portion is missing from the specimen as preserved. In addition he fails to make any reference to roots, although in his reconstruction of the tooth he shows the anterior missing portion to have terminated by means of such structures, while finally he makes no reference to the age or degree of development of the tooth.

Through the courtesy of the Acting-Director of the Port Elizabeth Museum, in which institution the tooth is preserved, the present writer has had the opportunity of examining the specimen.

Although Broom states that the tooth belongs to a lower jaw no reason is given for this conclusion, which, in the writer's opinion, is not correct. Van Hoepen (3) has shown that it is possible to ascertain whether a loose wart hog tooth belongs to an upper or lower jaw by the fact that in an upper the "second side cone protrudes farther from the tooth than any of the other cones." This characteristic was utilised to identify the upper molar discovered by the writer. However, due to the fact that the missing anterior portion of the *N. capensis* tooth includes the first side column and the greater part of the outer surface of the second, it fails to serve as a means of identifying this tooth. The tooth has, nevertheless, the general form associated with a tooth from the upper jaw, and since in addition it resembles the upper molar now discovered both in its great width and in its possessing "extra" columns on the outer side of its anterior side columns, it is most probable that it belongs to an upper jaw. On the specimen, as preserved, there is evidence on the occlusal surface of four pairs of side columns and five median columns, but, as shown by Broom's reconstruction, it is probable that five pairs of side columns and six median columns were present prior to post-mortem injury. The worn condition of the columns and the fact that at the distal end of the tooth there are no columns below the level of the masticatory surface, show that the tooth belongs to a comparatively old animal and thus has reached a fairly late stage in its development. Although the base is considerably damaged there still remains evidence that roots were present at this situation, and the condition of the columns indicates that they were well developed. All the columns have a relatively short vertical extent. The anterior columns on the specimen as preserved are shorter than the columns in the middle of the tooth, and these in turn are shorter than the distal columns. This decrease in size from behind forward is the typical condition in old teeth of the wart-hog type, and shows that the columns on the anterior missing portion of the tooth were even shorter than any of the existing columns. This is confirmed by the position at which the anterior portion has broken away. Like the *N. capensis* tooth the third molars of the modern wart hog are strongly built. At stages of their development, such as those illustrated by the molars B and C in fig. 2, great force is required to fracture them. At the stage D, however, relatively slight force will remove the anterior portion of the tooth, and examination shows that the line of fracture corresponds with that seen on the *N. capensis* tooth. The explanation of the modern tooth being easily broken at its anterior portion is that this portion is weak due to the presence of short columns and long roots. It seems

rational, therefore, to conclude that the loss of the anterior portion of the *N. capensis* tooth is due to a similar cause. The columns must therefore have been exceedingly short, and in fact could hardly have exceeded 12–15 mm. in length. It has been shown, however, when dealing with the teeth of the modern wart hog that shortening of the columns does not occur until after roots are developed, and that the shorter the columns the more complete is the root development. It must therefore be concluded that the anterior columns in the fossil terminated by means of long closed roots, while the remaining columns also possessed roots not so far advanced, however, in their development and in their degree of closure.

In other words, the evidence shows that in the length of its columns and in its root development the *N. capensis* tooth originally presented the same characters as would have been shown by the writer's specimens had they continued to develop and become worn. Furthermore, in view of the presence of roots the original height of the tooth must have been considerably greater than that stated by Broom. It seems possible that at the distal end of the tooth a root length of 15–20 mm. was attained, in which case the original total height of the tooth was 60–65 mm., which also corresponds to the height of the writer's specimens. At their occlusal ends the columns are of large size and complex form, and few in number. They have the characters seen in the Sterkfontein upper molar when it is viewed in section, as shown in fig. 3. It is obvious, therefore, that at an early stage of development of the tooth a larger number of columns were present, and these had not the form now presented but were smaller and of simpler form. In fact they must have closely resembled the condition of the columns in the Sterkfontein molars, and more especially the upper molar found in that district.

As stated by Broom, the tooth is remarkable on account of its great width. It has, however, already been pointed out that the upper molar discovered by the writer would eventually have reached the same width, 30 mm. It must therefore be concluded that in the form and size of its columns, in the degree of development of its roots as well as in its great width and other dimensions, it originally had characters which closely correspond with those which the Sterkfontein upper molar would have attained with further development. That is to say, it has characters which warrant the conclusion that it has developed from teeth of the same type as those now discovered. Conversely, the teeth now discovered have characters which warrant the conclusion that they are young teeth of the species *N. capensis*.

THE *N. meadowsi* TOOTH.

Broom's description of this tooth is also brief, but his illustration (fig. 5) shows clearly its main characters. Its greatest antero-posterior length at the base of the cusps is 76 mm., its greatest width at the same situation is 19 mm., and its height at the third inner cusp is about 65 mm.

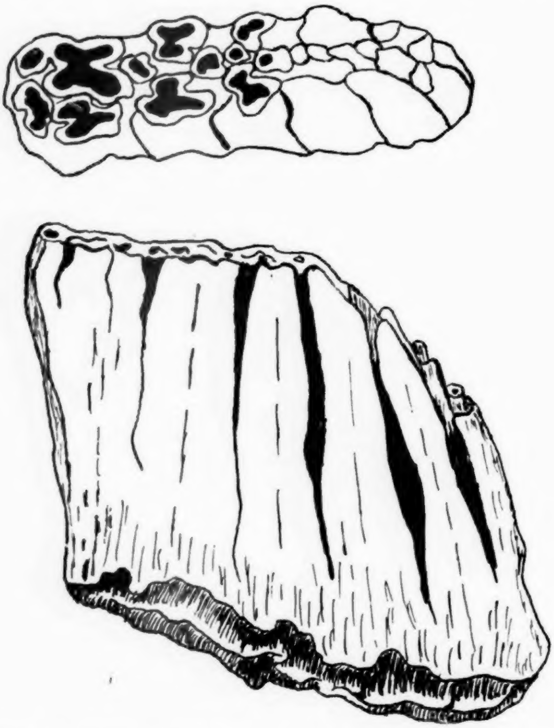

FIG. 5.—Third lower molar of *N. meadowsi* (Broom). Natural size upper and outer view (after Broom).

It has six pairs of side cones and eleven median cones, and although no mention of the fact is made by Broom, it is evident from the small degree of wear which these exhibit that the tooth belongs to a young animal.

Both in form and size this tooth closely resembles the writer's specimens. Except that it presents a larger number of abraded columns, it is almost identical with the writer's lower molar B. The lower molar A differs from the latter and also from the *N. meadowsi* tooth by possessing roots. It has

been shown, however, that the specimens A and B belong to the same lower jaw, and that lack of roots on the latter is the result of post-mortem injury. Broom's illustration shows that at the base of the *N. meadowsi* tooth similar injury has occurred, and while it is now impossible to state definitely that the damaged base terminated in roots, the close resemblance between the three teeth clearly indicates that such was the case. By removing the root from the specimen A the resemblance is made much more obvious. This was done, as shown in fig. 6. From this figure it will be seen that at their

FIG. 6.—Lingual view of the lower left third molar (specimen A) found at Sterkfontein after removal of its roots. About $\frac{2}{3}$ natural size. (Compare with Broom's *N. meadowsi*, lower third molar.)

bases the specimens A and the *N. meadowsi* tooth are now identical. The figure also shows how easily the former existence of roots may escape observation when teeth are discovered in a damaged condition.

It must therefore be concluded that the *N. meadowsi* tooth originally possessed roots, and since in addition it is similar in size, form, and number of columns to the writer's lower molars, it must be regarded as belonging to the same species. That is to say, it must be considered a young lower third molar of the species *N. capensis* and the name *N. meadowsi* must be abandoned.

THE AGE OF THE DEPOSITS AND OF THE FOSSILS.

As has already been shown, two of the teeth reported on were found in the diamond gravels of the Vaal River and three teeth were found at the Sterkfontein Caves. According to Broom (1 and 2), the diamondiferous gravels of the Vaal are probably of Pleistocene and possibly of Pliocene Age, while the Sterkfontein Caves probably belong to the Upper Pleistocene.

According to the same authority, the *N. capensis* tooth discovered at Longlands is probably contemporaneous with the gravels. The remaining four teeth probably also belong in age to the geological deposit in which they were found, but conclusive evidence on this point is lacking.

Although the Vaal watershed and the Sterkfontein Caves have yielded respectively the bones of the fossil apes *Australopithecus africanus* and *Australopithecus transvaalensis*, little accurate information is available concerning the precise geology of either deposit. Additional data is, however, constantly being secured, and with the discovery of further mammalian remains it may be expected that eventually many of the present geological uncertainties will be clarified. Meanwhile the geological age of the fossils here reported on must remain a matter for conjecture. The fossils show, however, that so far as one species (*N. capensis*) is concerned the fauna of the Vaal valley and of Sterkfontein were similar. In itself this fact does not warrant the conclusion that the diamond gravels and cave deposits are contemporaneous. Nevertheless it associates the two deposits, and indicates that they are more closely associated with one another geologically than has seemed probable from previous discoveries.

Summary and Conclusion.

It has been shown that at the Sterkfontein Lime Works, near Johannesburg, there were discovered three third molar teeth of an extinct pig. In view of the characters of the teeth and the facts associated with their discovery it has been concluded that the three teeth belong to one animal, and consist of one upper and two lower third molars. The teeth have been described and their characters compared with the third molars of modern wart hogs. It has been shown that, although very much larger in size, the form of the teeth warrants the conclusion that their mode of development was similar to that of the third molars in the wart hog.

The characters of Broom's *N. capensis* tooth are discussed, and it is shown that with further development the upper molar discovered at Sterkfontein would have presented similar characters. It is therefore concluded that the Sterkfontein teeth belong to a young member of the species *N. capensis*. Lastly, the characters of Broom's *N. meadowsi* tooth have been shown to be identical with those of the Sterkfontein lower third molars, and it has therefore been concluded that this tooth also must be classified as a young *N. capensis* tooth. In other words, the investigation has shown that if allowance is made for individual variations of teeth, especially those due to age, and if in addition there is taken into account the difference between upper and lower third molars, the teeth discovered by Broom and the writer respectively belong to the same species *N. capensis*.

The investigation has also shown that remains of this species are found both in the Vaal gravels and in the Sterkfontein Caves. It has therefore associated the fossils found in these important deposits.

ACKNOWLEDGMENTS.

To Professor Raymond A. Dart of our Department of Anatomy, to Mr. Barlow of the Sterkfontein Lime Works, and to Dr. J. Staz and Mr. P. Oranje of our Department of Dentistry, the writer is indebted for assistance in connection with the recovery of the fossils and the preparation of this report.

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DESCRIPTIONS OF NEW FORMS OF THE GENUS ACONTIAS LIN.

By JOHN HEWITT.

(With Plates II and III.)

The South African genus Acontias is referable to many forms, which have long been grouped under three species. One of these species, *lineatus*, is sharply separated from the other two. All other forms are classified on tail characters chiefly: those with tapering tails fall under *plumbeus*, and those with more or less cylindric tails under *meleagris*. In the south and south-west areas of the Cape Province only the cylindric type occurs: the tapering type extends from Mozambique southward about as far as Port Elizabeth, and occurs also in Namaqualand. A certain amount of intergrading occurs and some specimens are difficult to identify confidently with either group. Most of the forms have a limited geographical range, and each area usually contains only one form; occasionally, as at Grahamstown and Port Elizabeth, two forms occur side by side, members of different groups: apparently two forms of the same group do not occur together.

Acontias meleagris lineicauda subsp. nov. (Pl. III, fig. 1.)

Types.—A series of specimens from Dunbrody, Uitenhage district, C.P., collected for the Albany Museum by Rev. K. Tasman, S.J.

This form has been confused with *lineatus* Ptrs., but the differences are considerable. The tail of *lineatus* tapers a little, and at the end is suddenly carried to a point: the snout projects more strongly in *lineatus*, and below is rather flattened, which is not the case in *lineicauda*: typical *lineatus* has only a single supraocular, and the lower eyelid is transparent, whereas in *lineicauda*, as in other forms of *meleagris*, the eyelid is only translucent.

It considerably resembles the Grahamstown form *orientalis*, but is much more slender, the body stripes are thinner, and there are only two supraocular scales instead of 3.

Head slender, body cylindric and very slender; tail cylindric, only very slightly tapering, bluntly rounded at the end. Interparietal scale relatively large, almost an equilateral triangle, the base broader than the sides in the young. Supraoculars 2, the first relatively large and rather

longer than broad. Supraciliaries 4. Around the middle of the body 14 scales.

Body and tail pale, ornamented with thin dark stripes: stripes occur on all the scales of the tail, above and below, 4 thicker ones dorsally and 5 thinner ones at the sides and below: on the body 6 continuous stripes above, also on each side a continuous series of dark dots and below this a discontinuous series of smaller dots extending a considerable distance. The mid-dorsal pair of stripes is narrower than the pale interspaces. Ventrally the body is immaculate, except on chin and throat where lines of dark dots occur along each row of scales: in the throat region, the body has 21 such lines corresponding to the scale rows. Over the middle area of the body, the scales of the two mid-dorsal rows are broadened, but not so strongly as in the young of the Grahamstown form *orientalis*. Mesial row of subcaudal scales sometimes much broader than the adjacent scales, sometimes scarcely broader than adjacent scales.

Measurements.—Greatest breadth of head 4·8, total length 185 (1 : 38·5); length of tail 28.

For comparison, a small striped specimen of *orientalis* from Coldspring, near Grahamstown, measures: greatest breadth of head 5, total length 165 (1 : 33); length of tail 29. The tail of young *orientalis* is slightly more tapering than in *lineicauda*: the snout is slightly longer in *lineicauda*. Other specimens are in our collection from Farm Middleton, near Carlisle Bridge (Q. Blackburn) ; from farms Uniondale and Lower Governor's Kop, near Grahamstown (J. Hewitt); from Redhouse (T. V. Paterson): it occurs also at Port Elizabeth (J. T. Pringle). The largest Middleton specimen is 191 long, thickness of body 5.

At Dunbrody, Father Tasman collected these lizards in soft humus and earth around decayed stumps of Spek-boom (Portulacaria) and fallen Aloes and Euphorbias: the vegetation is mostly of karroid type, including a little grass. In the same area he found also a plain form, *Acontias plumbeus tasmani*, and specimens of *Scelotes caffer*, all three species living side by side.

Geographically, *lineicauda* favours the dry bush country of the Fish River and Sundays River valleys: *orientalis*, the larger Grahamstown type, is common at the coast, and also on the relatively damp mountain ranges of Albany.

There is apparently a little intergrading: an East London specimen has the dark stripes thinner than in *orientalis*, and a young specimen from that locality has the tail faintly lined below: a young specimen from Kleinemonde, in Bathurst district, also has the tail lined below, and, moreover, there are only 2 supraoculars, but a larger one from the same neighbourhood has 3 supraoculars and agrees well with *orientalis* except

that the dark lines along the body are narrower than in Grahamstown specimens.

Acontias breviceps Essex.

Records Albany Museum, vol. iii, p. 332, 1925.

This is known to us only from mountain localities in the Amatola region—Hogsback, summit of Katberg, and Finella Falls on the Winterberg.

The tail and head are rather short: the former tapers slightly, though it is not slender. The form of the interparietal varies, but is moderately elongate: in one young example it is very elongate. The prefrontal is of elongate type, and first preocular sometimes decidedly elongate, but this condition varies. All the scales (Pl. III, figs. 4 and 5), including head and tail, are spotted with black, below as well as above, a very distinctive feature: each scale is crossed by a broad dark spot: ventral surfaces paler than upper. There is no trace of striping.

From Sabie at 6000–6500 feet in the Transvaal (coll. G. A. Ranger), we have an Acontias mottled above and below remarkably like *breviceps*. It is bigger than *breviceps*, total length 237 mm., the tail being 40. The tail, is more tapering than in *breviceps*, the head is rather longer, snout a trifle more elongate. Interparietal a little elongate, supraoculars 3; around middle of body 14 scales. It is evidently a variety of *breviceps*, linking up with *plumbeus* which it resembles in the tail.

Acontias meleagris Lin.

In the Western Cape Province this species is often spotted or mottled, and the spots may merge sufficiently to produce stripes, but in adults at any rate the spots never fuse completely. In the Eastern Cape Province it is normally well striped, the spots being completely fused. No doubt various local races could be distinguished amongst the striped assemblage, but this has a wide distribution and seems to merit recognition as a subspecies which I now name:

Acontias meleagris orientalis subsp. nov. (Pl. III, fig. 2).

Types.—A series of specimens from Grahamstown, now in the Albany Museum. Body with 6 dark stripes above, also an imperfect outer row on each side consisting of a series of dots, best developed in the anterior half of the body. The broadest stripes are the mid-dorsal ones: these throughout are broader than the pale interspaces, much broader in the hinder half of the body. Tail with 6 stripes, also a row of dark spots on each side inferiorly: in two male specimens there are 9 stripes, including 3 ventral rows of spots, nearly all the subcaudals being spotted except those near the vent. Head extensively infuscate above, generally with an irregular pale patch on the

snout, and usually all scales are pale-margined: sometimes the head is much mottled and speckled. Around middle of body 14–16 scales: mid-dorsal pair markedly broadened in the middle and hinder parts of the body, and over the base of the tail, much broader than the adjacent scales. Tail thick, but tapering slightly, always stouter than in *gracilicauda*. Supraocular scales 3, the first one more or less squarish, sometimes broader than long, sometimes considerably longer than broad: supraciliaries 4; frontal and interparietal generally broad, and head broad behind.

Total length 252, tail 46, thickness of body 10.

In life, the upper and lateral surfaces are bright yellow, and the stripes very dark brown: lower surfaces very pale. Base of tail not noticeably swollen in adult male.

In the young, the head scales are black with thin pale margins: adults sometimes lack the sharply defined pale margins. The bony plates of the body are much stronger than in *gracilicauda*.

We have striped specimens also from Highlands, Coldspring, Alicedale, Aylesby, and Uniondale, localities in Albany; from Whitney, Cuylerville, and Kleinemonde on adjacent coast; from Cape St. Francis, East London, and Xukula, near Tabankulu, in the Transkei. In specimens from East London and Kleinemonde, the dark stripes are thin. Cape St. Francis specimens have the head extensively blackened and the head scales narrowly pale-margined, rather faintly so in one example. The Xukula specimen, a young male, has the head scales closely mottled, not pale-margined: throat with some dark spotting: lower surface of tail is striped.

What we may regard as the typical form of *meleagris* includes a number of local races, all with a blunt stumpy tail which does not taper, or only very slightly, and the interparietal scale is more or less an equilateral triangle: supraoculars 3. I have examined material from the following localities:—Wellington (G. Theiler). Two specimens are the largest found in this species—total length 275 mm., tail 42·5, body thickness 12, breadth of head 8·5. Around the body 16 scales. One specimen has a rather narrow interparietal with rounded apex; base of triangle narrow. In two specimens the parietals are in good contact. All are relatively pale (Pl. II, fig. 1): above brownish, head finely speckled, and scales not pale-margined: 8 rows of body scales are mottled, but there are no distinct dark spots and no continuous striping—instead of spots is a local arborescence of pigment with slight concentration into a thin darkish band crossing the scale distally: lower surfaces and flanks quite pale, and lower surface of tail neither mottled nor striped. A young specimen is more distinctly striped along the body.

Paarl and Hermanus (Pl. II, figs. 2–5) a series (C. G. S. de Villiers). Young specimens are well striped over the whole length of the body; there

are 6 lines of fused spots, or 4 lines and an outer row of small spots on each side, or even 8 lines in a fairly young specimen from Hermanus: these lines are not sharp-margined, and in the first half of the body are all thin, thinner than the interspaces: generally the 2 mesial ones are thickest. Later on the stripes disappear, through increased infuscation of the interspaces. Infuscation increases on the tail, the dorsal scales being entirely infuscate towards its tip. The largest female specimen from Hermanus has rows of dark spots not fused up into stripes. A large one from Paarl has rows of dark spots only slightly fused up along the centres; interspaces pale; on the tail not fused up. A subadult from Paarl has 6 rows of spots connected along their centres, over the tail more completely so but not forming sharply defined stripes. Stellenbosch (C. G. S. de Villiers) a large specimen (277 mm. long) uniformly dark above: tail finely spotted below but not very closely so.

Cape Peninsula (South African Museum) a series of specimens. Generally the dorsal surface is nearly uniformly dark, due to blending of the dark spots, but it is usually somewhat mottled. This dark area, 8 scales broad, is sharply demarcated from the immaculate lower surfaces. Several specimens from Devil's Peak are distinctly striped, but not so sharply so as in Albany specimens: the tail is spotted below, and sometimes also the body. Interparietal may have sides longer than the base, but is never strongly elongate: the condition varies amongst individuals from the same locality. In Robben Island specimens the tail is spotted below, sometimes only towards the end, or only weakly here and there. In this series the interparietal is broad-based in small or moderate-sized specimens, a little elongate in the largest specimens: in all these the parietals form a suture, but in Cape Peninsula specimens the parietals may or may not meet.

Knysna, a single specimen, very dark throughout above, the spots being completely fused except those of the most lateral row: tail coarsely spotted throughout below, and lines of small dark spots occur also on the throat.

Bos River Kloof, near Cango Caves (Miss G. Pickford): 2 large specimens probably represent a distinct race, the tail being more slender and tapering: dorsal surfaces well spotted, but the spots do not fuse over the greater portion of the body: anteriorly and over the tail more or less complete fusion occurs: tail immaculate below: head mottled above.

Great Brak River (Miss G. Pickford), a very young specimen, 92 mm. long: it is for the most part very pale, becoming darker over the tail where the individual scales are dark-margined: for a very short distance behind the head the upper surface is faintly striped.

Humansdorp (C. G. S. de Villiers), one thick-tailed specimen with 8 well-defined rows of dark spots which do not fuse up: the 2 mid-dorsal rows are of broad spots, broader than the interspaces even in the anterior half of the

body. There are 3 supraoculars on the right side, 2 on the left. In pattern it is rather nearer to the Hermanus race than to that of Grahamstown.

Graaff Reinet (J. S. Taylor), a single specimen with 10 rows of dark spots which do not fuse up: these spots are not very intense, and examined under a lens are seen to have the pigment much broken up into lines or arborescent forms. The tail tapers slightly and is mottled below rather weakly, most of the broadened scales of the mesial row being spotted, and likewise those of the adjacent row on each side. Very faint spotting also occurs on some of the belly scales and on the throat. The mottling of the subcaudal scales and the partial disruption of the spots may perhaps indicate some admixture with the Sundays River form *tasmani*, but no doubt the main affinity is with *meleagris*.

Acontias plumbeus tasmani subsp. nov. (Pl. III, figs. 6 and 7).

Types.—A series of specimens from Dunbrody, Sundays River, Cape Province, collected for the Albany Museum by Rev. K. Tasman, S.J.

This form is a connecting link between *gracilicauda* and the western forms of *meleagris*.

It differs from *gracilicauda* Essex (Records Albany Museum, iii, p. 334) in the shape of the interparietal scale, which is more or less an equilateral triangle; sometimes the base is broader, or the sides may be longer, but never much longer than the basal width. Fore part of head slender and long, hinder part not broad; 3 supraoculars, first usually longer than broad, sometimes only slightly so: frontal scale not very large, rather longer than in *orientalis* but shorter than or about as long as the rostral, and the hind margin usually shallowly curved, mid-dorsal scales about the middle of the body decidedly broadened, but not very greatly so. Tail rather long, tapering gradually but distal half not noticeably slender; a large female has near the base ventrally 5 or 6 pairs of scales, then a single series of much broadened scales: an adult male and immature female have only 3 or 4 pairs of scales at the base. Anal plate of female broader and more broadly rounded than in male. Around middle of body 14–16 scales.

Head scales finely mottled or speckled with brown, never wholly infuscate; their margins are not pale as often the case in striped forms. Dorsal surfaces generally brownish or more or less leaden colour, uniformly so except for the somewhat paler margins: ventral surfaces pale, except the tail of adult female which has dark mottlings on all the scales. Very young specimens resemble the adults in colour: there is no trace of striping, no definite spots apart from an accumulation of pigment along the distal margins of the scales, and the head scales are uniformly finely speckled. Total length, M. 231, F. 260; tail, M. 40, F. 49·5; breadth of head, M. 7·5, F. 8.

The same form is known also from Uitenhage (C. G. S. de Villiers), Redhouse (T. V. Paterson), and Port Elizabeth (J. Pringle, F. Cruden). The Port Elizabeth series has the interparietal of variable shape, equilateral or a little elongate, in one example fairly considerably so: one specimen has only 2 supraoculars on the left side: this series approaches closely to *gracilicauda*, but the tail is not so slender as in that form, and the interparietal not quite so elongate. As in *gracilicauda* there are no compact spots on the scales, even those of the lateral rows: examined under a lens, the pigmentation appears branched, diffuse or reticulate. On the upper surface of the tail in *plumbeus* specimens, the scales tend to become uniformly infuscate, especially near the tip of the tail.

Two records from the dry bush of the Fish River valley may also be included:—

Kleinpoort, near Committees (J. Hewitt). A single specimen much bleached to a light brown tint, showing no trace of stripes, and spots are only noticeable laterally but are not conspicuous: dorsally the pigmentation is much broken up, giving a finely mottled or peppered appearance. The tail is decidedly tapering, and in general appearance there is an approach to *tasmani*. The interparietal is equilateral, the first supraocular a trifle broader than long, a character distinguishing it from *tasmani*, but admixture therewith seems probable.

Resolution, near Fort Brown (Miss A. Walton), 3 adults, 1 half-grown and 1 juvenile; the adults are spotted, and the spots may be quite separate in the first half of the body, or more or less fused into stripes but the stripes are not sharp-margined and the pigmentation is finely peppered: a half-grown specimen also has the spots fused into stripes which are not sharp-margined. Here are two forms very similar in scaling. The striped ones, adult and young, are a local race of *orientalis*: pigment on each scale tending to extend lengthwise but not spreading laterally: striping of hinder half of body rather sharper than anteriorly, and two mesial stripes rather broad. The spotted ones, adult and young, have rather more slender head, tail rather more tapering: examined under a lens, the pigmentation is an arborescent reticulation extending right across the hinder portion of each scale and tending to disappear in the anterior half. This falls under *tasmani*.

A male specimen from Omatjenne, near Otjiwarongo, S.W.A., shows some resemblance to Dunbrody specimens, but differs in head-scaling, the interparietal being more elongate and the frontal being larger: lower surface of body and tail quite immaculate and pale: 16 rows of scales around the body. A young specimen from Omatjenne has upper surfaces of head and body entirely blackened: tail pale but not white below, body below slightly infuscate, but with no traces of spots or stripes anywhere: inter-

parietal equilateral. This form is no doubt a distinct subspecies near to *plumbeus* Bian.

Acontius plumbeus gracilicauda Essex.

Records Albany Museum, iii., p. 334, 1925.

This form is known to us from Grahamstown, Koonap, Alicedale, and Gleniffer, near Kei Rd. In life, Grahamstown specimens are more or less olive in colour: they are sometimes found in the same localities as *orientalis*. There is considerable variation in the form of the interparietal scale. The Gleniffer specimens are rather slender, with much elongate interparietal even in fairly young specimens. Colour dark leaden above, pale below. The Koonap specimen has also a much elongate interparietal: the typical form from Grahamstown has the interparietal moderately elongate, but in the young it may be only very slightly so, and the first supraocular may be only a little elongate; nearly squarish, the frontal elongate: a large specimen from Alicedale has well elongate interparietal, and likewise also the supraocular, whilst a young one has moderately elongate interparietal. A very young specimen, total length 102, has tail length 17·5.

Acontias lineatus Ptrs., Mon. Berlin, Ac., 1879, p. 774.

The type came from Hantam, which is in Calvinia district. The description is brief, but the figures show the distinctive characters sufficiently well: it is the same form as that found at Steinkopf. In this there are 3 supraciliary scales, the first and third moderately large, the second quite minute: there is only a single large and elongate supraocular, which, however, is followed by another elongate scale of smaller size. In the British Museum Catalogue it is stated that 2 supraoculars occur: the description there given is presumably based on the single adult specimen mentioned as taken in the "Karroo"—actually we do not know of Karroo records for this species: the 2 supraoculars of this specimen are probably the 2 scales above mentioned, only one of which is strictly speaking a supraocular.

This typical form is represented in our collection by 3 specimens from Steinkopf: in one of these there are only 2 supraciliaries. Probably the form is confined to Namaqualand and neighbourhood.

In Boulenger's Revised List of South African Reptiles and Batrachians (Ann. S.A. Mus., vol. v, p. 490) there are various other records for *lineatus*, most of which must be erroneous: these errors are Capetown?, Port Elizabeth, Dunbrody, and probably also Malmesbury. The Port Elizabeth and Dunbrody records are no doubt based on the form here described as *lineicauda*.

A distinct subspecies of *lineatus* is known to me from Kakamas and Hopetown: this I now name:

Acontias lineatus orangensis, subsp. nov.

Types.—Two specimens from Kakamas collected for the Albany Museum by Miss H. C. Olivier.

The distinctive characters are, 2 supraoculars and 4 supraciliaries. The two supraoculars are not much elongated: they are followed by a single slightly elongate scale as in the typical form. The first supraciliary is rather large, the second and third small, the fourth of moderate size. Interparietal scale equilateral, or base broader than the sides. 14 scales around the body. 8 rows of spots along the upper surface of the body, the outer pair faint and quite lacking just behind the head. The terminal portion of the tail is somewhat flattened, especially the ventral surface, and the apex is bluntly pointed. Total length 176, tail 38. A specimen from Hopetown has only 3 supraciliaries, the middle one being of moderate size.

In the head-scaling *orangensis* shows approach to *meleagris*, but the depressed snout and end of tail seem much as in typical *lineatus*.

Acontias plumbeus namaquensis subsp. nov. (Pl. III, fig. 3).

Types.—A single adult from O'okiep, Namaqualand, presented to Albany Museum by Dr. R. W. Howard. We also have a smaller specimen from Steinkopf, and a juvenile from Kamiesberg (3500–4500 ft.) collected by Capt. G. C. Shortridge. A feature of these specimens is the unusually slender tapering tail: also, the broader interparietal separates it from *gracilicauda*, and the pigmentation is much weaker than in that form or *tasmani*. 18 scales around the middle of the body in all three specimens. Interparietal with sides nearly a third longer than the base in the type, a little longer than the base in the Steinkopf specimen, but a little shorter than the base in the Kamiesberg juvenile. Head rather broad behind, but snout narrow. 3 supraoculars, the first longer than broad in the type and juvenile specimens, squarish in the Kamiesberg specimen. The mid-dorsal rows of scales are not much broadened except over the tail and a little anterior thereto: in *meleagris* much broadened scales occur from about the middle of the body or still more anteriorly. In the type specimen, all the dorsal scales of body and tail are conspicuous owing to sharply defined pigmentation along the scale margins: this in the body applies to about 6 rows: the head is brownish with minute pale freckles. In the two smaller specimens, the dark edging of the body scales is irregular, having concentrations on the anterior and posterior borders forming ill-defined transverse spots, and distinct longitudinal rows of transversely disposed spots occur on the sides of the body. Measurements: total length 239, tail 37·5, width of head posteriorly 8·9, width of body about middle 9, width of tail at a point about $\frac{1}{5}$ of its length from the tip 3·5. The youngest specimen of total length

131 has tail 24·7. Very young specimens of *gracilicauda* from Grahamstown show about 12 inconspicuous rows of spots along the body, these spots being bigger than in *namaquensis*: they are transversely elongate, not tending to fuse together into lines, although some fusion occurs on the tail.

EXPLANATION OF PLATES.

PLATE II.

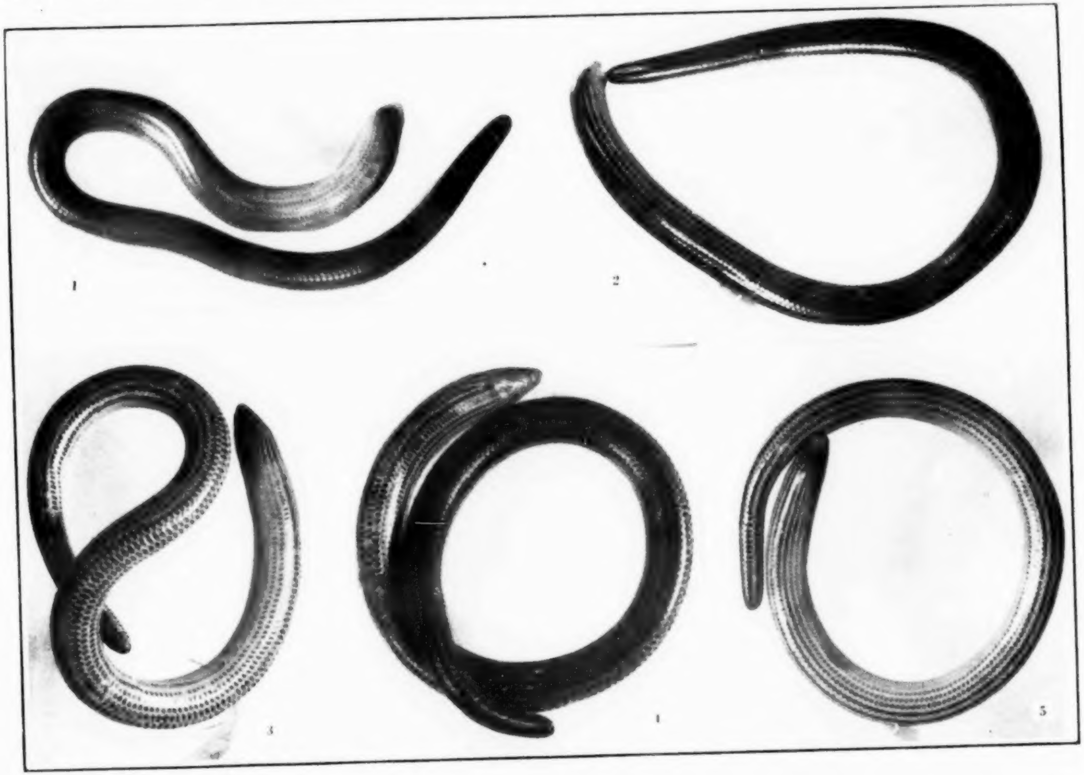
Acontias meleagris meleagris Lin.

1, from Wellington; 2, from Hermanus; 3–5, from Paarl.

PLATE III.

1. *Acontias meleagris lineicauda* subsp. nov., from Middleton, near Carlisle Bridge.
2. *Acontias meleagris orientalis* subsp. nov., from Nature Reserve, Grahamstown.
3. *Acontias plumbeus namaquensis* subsp. nov., from O'okiep.
4. *Acontias breviceps* Essex, from Finella Falls, Great Winterberg. 5. Ventral surface of type.

6 and 7. *Acontias plumbeus tasmani* subsp. nov. Type specimens from Dunbrody, Sundays River.

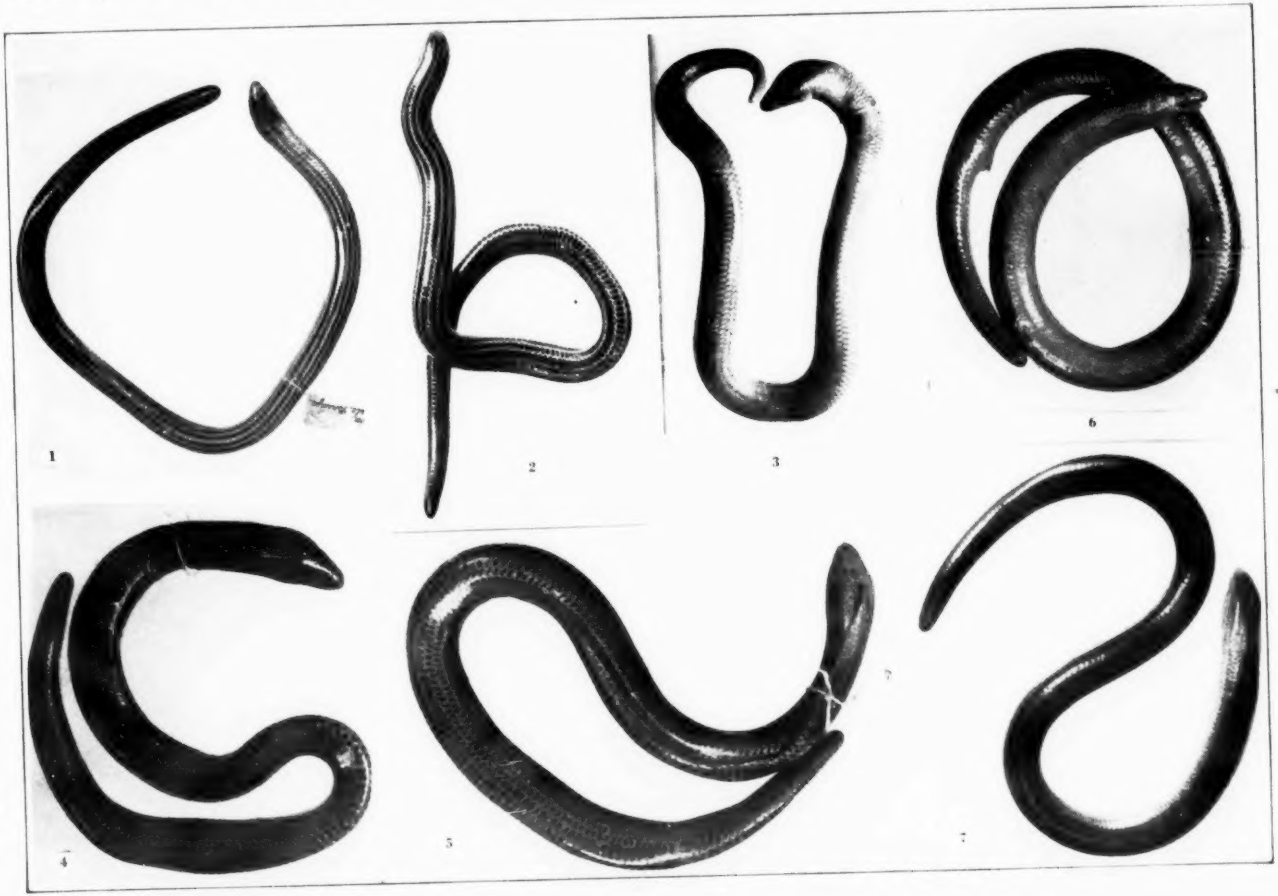


Acontias meleagris meleagris Lin.

1. From Wellington. 2. Hermanus. 3–5. Paarl.

J. Hewitt. Neill & Co., Ltd.

Plate III.



1. *Acontias meleagris lineicauda.* 2. *A. m. orientalis.* 3. *A. plumbeus namaquensis.* 4 and 5. *A. breviceps.*
6 and 7. *A. plumbeus tasmani.*

J. Hewitt.

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THE SOUTH AFRICAN INTERTIDAL ZONE AND ITS RELATION TO OCEAN CURRENTS.

II.—An Area on the Southern Part of the West Coast.

By K. M. F. Bright, M.Sc.

(Department of Zoology, University of Cape Town.)

(With Plates IV–VI, and one Text-figure.)

(Read May 19, 1937.)

CONTENTS.

Introduction.

This paper is the second of a series dealing with the effects of cold and warm currents on the intertidal fauna and flora of the shores of the Union of South Africa. The work is being carried out from the Department of Zoology of the University of Cape Town, under the direction of Prof. T. A. Stephenson. The general plan of the investigation, and the methods employed, have already been explained in the first paper of the series, which describes a general ecological survey of the intertidal region carried out at Still Bay (Stephenson, Stephenson and du Toit, 1937). The present account embodies the results of a similar survey of the neighbourhood of Oudekraal, on the Atlantic coast of the Cape Peninsula, an area influenced by the cold Antarctic intermediate water which upwells along the west coast of the Union.

The survey of Oudekraal extended over a considerable period. It was carried out principally in 1934, during which year most of the available tides were utilised for field-work. Supplementary observations were made in October and November 1936.

In the first paper of this series, an annotated list was provided, giving the names of all the species collected during the survey (of Still Bay) for

which identifications had been received at the time of publication. It has been decided that in the remaining papers similar lists will not be included; but these will be presented as a comparative table in a later paper devoted to the consideration of the geographical relations of the intertidal biota of the Union as a whole.

I wish to convey my thanks to E. J. Eyre, M.Sc., to whom I am much indebted for assistance in carrying out the field-work of the survey; to Dr. G. J. Broekhuysen for the photographs reproduced in Plates IV and V; and to Prof. Stephenson for guidance throughout the investigation. The material collected has been identified by the specialists whose names appear on p. 349 of the Still Bay paper, to all of whom sincere thanks are offered for their invaluable assistance. To the names formerly given must be added those mentioned below. Systematic papers dealing with Oudekraal material have been published by Burton (1936), Carlgren (1935), and O'Donoghue and de Watteville (1937).

Alcyonaria. Prof. S. J. Hickson (Cambridge); Mrs. L. M. I. McFadyen (British Museum).

Nemertinea. Dr. J. F. G. Wheeler (Bermuda).

Gephyrea. Dr. A. C. Stephen (Royal Scottish Museum).

Mollusca. R. Winckworth, Esq. (Royal Society, London).

Algae. Prof. H. Kylin (Lund); Dr. A. V. Manza (California).

Description of the Locality.

Oudekraal (Lat. 33° 59′ S., Long. 18° 22′ E.) is situated near Cape Town, on the Atlantic coast of the Cape Peninsula. The locality derives its name from a farmhouse lying close to the shore at a distance of about 2½ miles (4 km.) in a south-westerly direction from the village of Camps Bay.

The land in this region slopes very abruptly into the sea, forming a steep incline which descends from the mountains (the Twelve Apostles) into the waters of the, Atlantic. The mountains and upper talus slopes are composed of grey quartzitic sandstones of the Table Mountain Series, resting unconformably on coarse-grained porphyritic biotite-granite (A. L. du Toit, 1926). Outcrops of the underlying granite constitute the greater part of the coastline and weather into smooth rounded expanses and boulders, often of enormous size, which form promontories at irregular intervals along the coast. Three such granite masses are included in the region studied at Oudekraal. Of these the most northerly is much the largest, and contains an island and several outlying blocks or islets, known as the "Geld Kist" (fig. 1), in addition to the usual boulder-strewn promontory. From the Geld Kist a rocky beach stretches some 150 yards (140 metres) to the south-west; it is a tumbled chaos of large angular

fragments of sandstone (often 10 feet—3 metres—in diameter) which have fallen from the talus slopes above. This terminates in a clump of granite boulders of considerable size, on which the main work of the survey was carried out, and which will be called the "Homestead Rocks" in this paper,

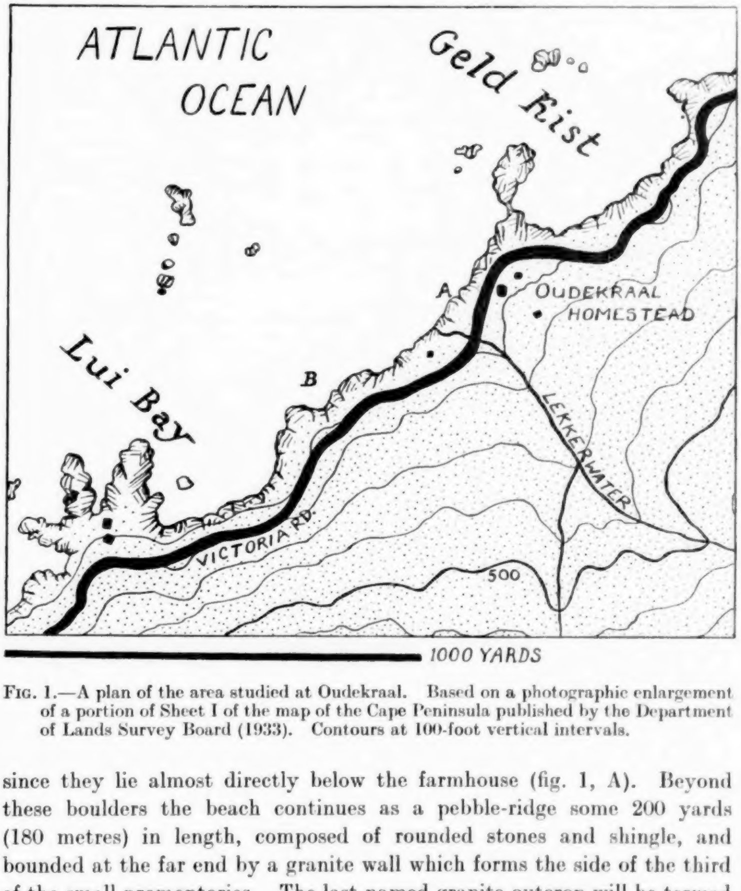

FIG. 1.—A plan of the area studied at Oudekraal. Based on a photographic enlargement of a portion of Sheet I of the map of the Cape Peninsula published by the Department of Lands Survey Board (1933). Contours at 100-foot vertical intervals.

since they lie almost directly below the farmhouse (fig. 1, A). Beyond these boulders the beach continues as a pebble-ridge some 200 yards (180 metres) in length, composed of rounded stones and shingle, and bounded at the far end by a granite wall which forms the side of the third of the small promontories. The last-named granite outcrop will be termed "Lui Bay Rocks," as the inlet known as Lui Bay lies immediately beyond it (fig. 1, B). There are no expanses of sand except at the Geld Kist, where small quantities of coarse sand and gravel occur between the rocks, and floor the channel between island and mainland.

A stream of fresh water, the Lekkerwater, flows down the mountain

side and across the beach to the sea. It is, however, so small as scarcely to affect the surrounding population of the shore.

This part of the coast is to some extent protected by fields of kelp* which mitigate the force of the waves except in stormy weather, when the seas rush up the shore almost to the edge of the bushes and grass, considerably altering the configuration of the banks of shingle and tossing up large quantities of seaweed and other debris beyond the normal high-water mark. The outer boulders of the promontories are, however, very little sheltered by the kelp, and are nearly always splashed by the surf or by the heavy swells which break over them even in calm weather.

In addition to the main survey of the Homestead Rocks, with which were included the adjacent parts of the shingle and rocky beaches, a less detailed examination was made of the Geld Kist and of the Lui Bay Rocks. As these observations cover a comparatively small area, visits were paid to other parts of the shore in the same neighbourhood, but conditions there were found to resemble so closely those already described that it was not considered necessary for the purposes of this work to investigate them further.

The Homestead Rocks.

(Plate IV.)

These rocks are large outcrops of weathered granite, scattered amongst which lie a few smaller blocks of sandstone. The granite forms high rounded boulders with almost perpendicular sides; the outer ones are separated by deep water-filled channels into which the waves surge even at low water, while the channels between those nearer the land are shallower and wider. These channels are all sublittoral, but at low water the landward ones remain so calm and undisturbed, with hardly a current flowing through them, that they may almost be described as pools. A surprising profusion and diversity of animals dwell in these channels, particularly in the outer ones, which constitute one of the most densely populated types of habitat on the South African shore.

On account of the steep gradient of the coast, the intertidal area is not of great extent. On the shingle beach, where it is at its widest, the distance from the edge of the sea at low water of springs to the line of decaying kelp which marks the limit reached by the waves at high water is some 35 feet (11 metres). Above that the rocks and shingle continue for a further 60 feet (18 metres), up to the margin of the bushes and grass. In this upper supralittoral region the rocks are bare but for incrustations of lichens of various colours.

The intertidal area may be subdivided for description into four main

* The term "kelp" is used in this paper to denote the large brown algae which belong to the order Laminariales.

zones, which are easily distinguished on the boulders, though on vertical faces they tend to become much compressed, and in such places certain of the communities which characterise them may even be entirely lacking. On the shingle beach the division is less obvious owing to the presence of both horizontal and vertical differentiation.

I. *The sublittoral fringe.** The sublittoral region of the shore is dominated by Laminarians. The edges of this region may be examined among the outermost boulders, for although the greater part remains perpetually submerged, the upper margin is uncovered at low water when maximal tides coincide with calm weather, and may then lie in the splash-zone for some time. In this sublittoral fringe one of the most typical animal species on open rock is the limpet *Patella argenvillei*, which is present in fairly large numbers. Tufted and leafy red algae (*Champia lumbricalis* and species of *Gigartina*) are present in varying quantity amongst the limpets, flourishing especially in places where the rock is subjected to much wave-action, and there constituting a dense carpet which obscures the other animals of the region. Where more shelter is available, and on vertical faces, the algal growth tends to be very poor, apart from a variety of encrusting forms. Lower down kelp plants become common, and a few gigantic simple Ascidians (*Pyura stolonifera*) are to be seen; these may form large clusters in clefts, but on the open rock are usually isolated. Rich growths of red algae and sheets of brightly coloured sponges (*Fibulia ramosa, Tedania brondstedi, Myxilla simplex*, etc.) are also to be seen between the holdfasts of the kelp, their luxuriance depending on the amount of shelter provided by neighbouring rocks. Beside the sponges and limpets few animals are to be found apart from the epizoic fauna of the kelp. The foregoing remarks apply to the outer regions of the rock, but the sublittoral fringe extends for some distance inshore in channels; first in the deep outer clefts, and then in the shallower channel-pools among the rocks close to the beach.

II. *The zone of Patella cochlear.* This lies immediately above the sublittoral fringe. It remains submerged at minimal tides, but is exposed for a considerable time during maximal tides, throughout which period, however, it is usually intermittently splashed or washed by the surf. In very calm weather large expanses of limpet-covered rock in this zone may dry off completely and remain isolated for some time; but this is an unusual occurrence. Exposed rock surfaces in the zone are covered by a mosaic of *Patella cochlear*. These limpets are invariably associated with several

* In this series of papers the term "sublittoral fringe," introduced in the paper on Still Bay (this Journal, vol. xxiv, p. 360), is used throughout to denote the zone constituting the boundary between the sublittoral and littoral belts, the zone uncovered for a limited period when maximal tides coincide with calm weather.

types of lithothamnion,* which encrust both the shells of the limpets and the intervening rock, imparting to the whole area a monotonous greyish-buff colour frequently unrelieved by other algae, which are typically scarce in this community. The individuals of *P. cochlear* are on the whole of small size, but are exceedingly numerous, covering the rocks so densely that some become deformed owing to contact with neighbouring limpets.† This Cochlear community occupies large stretches of flat or gently sloping rock, the tops of stones, and to a lesser extent the seaward faces of the higher boulders. It is typically completely absent from the landward aspect of these boulders, and even on the seaward side rapidly dwindles and disappears as the rocks approach the shore. The upper margin of the zone is often clearly marked by a narrow fringe of a buff-coloured coral-like lithothamnion which is one of the types commonly occurring amongst the limpets.

III. *The Balanoid zone.* The distribution of barnacles along this part

* The word "lithothamnia" (not italicised and without a capital) is used throughout this series to denote the encrusting Corallinaceae; the word "corallines" to designate the jointed forms.

† A count was made of the population inhabiting one square yard (*ca.* 0·84 sq. m.) of rock, part of a low flat-topped granite boulder in the Cochlear zone, and the results obtained are tabulated below. The total number of limpets occupying this small area is remarkable, for the place selected was in no way unusual and was chosen as being typical of the Cochlear zone in this locality. All the specimens of *P. cochlear*, however, were not situated directly on the rock, for as a rule each of the larger individuals bore one or more younger ones on its shell.

Animals.		Number found.
Patella cochlear	Larger specimens (average length 2 inches)	386
	Specimens under 1 inch long	929
	Total number	1315
	Percentage of above seated on rock	42
	Percentage on shells of others	58
Mytilus crenatus		29
Bunodactis reynaudi		8
Patella argenvillei (small)		1
P. granularis (small)		10
P. granatina (small)		1
Siphonaria capensis		2
Algae (excluding lithothamnion).		**Plants found.**
Splachnidium rugosum		3
Iridaea capensis		5
Porphyra capensis		5

of the coast is somewhat variable, but two species (*Octomeris angulosa* and *Tetraclita serrata*) form a sufficiently constant element in the fauna of the region above the Cochlear zone to justify the use of the term Balanoid zone. Another typical, and less erratic, inhabitant of the zone is the limpet *Patella granularis*, which is notably common at this level.

The Balanoid zone falls naturally into two subdivisions, of which the lower is by far the more densely populated, and contains the majority of the barnacles. Both barnacles and rock are here frequently thickly encrusted with a greyish lithothamnion which whitens on exposure to the atmosphere, rendering them very conspicuous. Rock surfaces in the upper sub-zone appear very bare, since lithothamnia are absent, and animals inconspicuous and relatively scarce. For the most part bushy algae exist only as stunted plants sparsely scattered through the zone; but here and there occur in greater quantity.

The entire zone emerges at low water of springs, when it may become dry and remain so for long periods in calm weather. During tides of lesser amplitude the lower parts are not uncovered, though the upper portion may be exposed for some time.

IV. *The Littorina zone.* This is the uppermost of the intertidal zones, and extends above the level of high water of ordinary spring tides, so overlapping into the supralittoral region. The rocks on first examination appear to be almost uninhabited, for though a small snail, *Littorina knysnaënsis*, is typical of this zone and is found in myriads in the tiny crevices of the granite, it is difficult to distinguish from the black mica-crystals in the rock. The snails are quite conspicuous in hollows or fissures in the sandstone. Other animal species are rarely to be found in the zone, apart from the amphipods (such as *Hyale saldanha*) which haunt patches of algae, and a very small blue-black collembolan (*Anurida maritima*) which creeps about the stones.

Some of the boulders are covered with a thick cap of a ragged yellowish brown alga (*Porphyra capensis*), apart from which a microscopic species, *Calothrix crustacea*, is the principal alga found on the open rock; the latter stains the tops of many of the boulders to a greenish-black tint.

On the shingle beach small crustaceans are to be found throughout the uppermost regions. Ordinarily hidden, they appear in countless myriads when the stones are littered with decaying kelp after a storm. The chief species collected were *Ligia glabrata*, *Deto echinata*, and *Talorchestia capensis*.

Tide levels. In order to obtain some indication of the respective periods during which the different zones are exposed to the air at Oudekraal, the movements of the tide were observed throughout a period of eight hours, on 1st December 1936 (three days after full moon). The times

thus procured are as accurate as can be expected from such a method, for the sea was unusually calm, with no breaking waves, on the day chosen, and boulders exhibiting well-defined zonation were available. There was hardly any actual splashing at any time during the day, though slight swells kept the rocks wetted for a couple of feet above the actual level of the water.

Cochlear zone. Parts of this zone remained dry for some time, but the rest, though uncovered for a considerable period, was kept moist by occasional surges. The zone was dry for a time ranging between 0 per cent. and 25 per cent. of the tidal period,* according to position.

Balanoid zone. The lower subzone was left unwetted for a considerably shorter time than the upper. The time during which the whole zone remained dry amounted to 25 per cent. of the tidal period, but parts were exposed for as long as 50 per cent. of this period.

Littorina zone. Many of the specimens of *Littorina* were quite dry even at high water, as were the patches of *Porphyra capensis* on some of the rocks. This was probably due in part to the unusual lack of splashing. The exposure of the zone varied between 50 per cent. and 100 per cent. of the tidal period.

Further Notes on the occurrence of particular Animals.

1. *Barnacles.* Occasional barnacles (*Octomeris angulosa* and *Tetraclita serrata*) make their appearance among the upper individuals of *P. cochlear*, but their typical habitat lies at a somewhat higher level. On the outermost boulders they are not remarkably common, few *O. angulosa* occurring on the open rock, though crevices fringed with *T. serrata* often accommodate large numbers. On rocks nearer to the beach the *O. angulosa* become very plentiful, thickly populating a definite belt in the lower Balanoid zone, while still farther inshore they are almost completely replaced by *T. serrata*, which becomes abundant in angles between rocks and in other well-sheltered situations. Three other species belong to the fauna of Oudekraal. *Balanus trigonus* and *B. algicola* are small pallid barnacles commonly found at low levels on the shore, particularly on rock-surfaces in the sublittoral fringe and encrusting the shells of *Mytilus crenatus* and of the large *Balanus maxillaris* which often lives just above the margins of the sublittoral channels.

2. *Limpets.* The Patellids form an important section of the fauna, and comprise ten species of *Patella* and two of *Helcion*. *Patella granularis* extends highest on the shore; the animals are large and well-formed, reaching their greatest size on the shingle beach. Small specimens are often found

* By the "tidal period" is meant the interval between one high water and the next.

amongst *P. cochlear*, and frequent the lower parts of the Balanoid zone, while the upper Balanoid zone chiefly accommodates the larger individuals. *P. granatina* is uncommon on the outer boulders, but is notably plentiful on the shingle and rocky beaches, where its habitat extends down into the Cochlear zone. *P. oculus* * is comparatively rare, but when present is often of large size; it lives in the same region as *P. granatina*, though its zone of distribution is not so wide. *P. cochlear* † is so numerous in the zone it characterises as almost to obscure the rock within certain areas. *P. barbara* and *P. miniata* are widespread on rocks low down on the shore in the sublittoral fringe, where they are almost permanently submerged. *P. barbara* is the more abundant of the two species, and often attains a large size, the shell in many cases becoming overgrown with grey lithothamnion and worm-tubes (*Spirorbis borealis*), or infested with algae. Only one specimen of *P. longicosta* was found during the whole course of the survey, in spite of careful search. *P. argenvillei* occupies the upper margin of the sublittoral fringe, where it is fairly common and is conspicuous on account of its large size; and occasional examples are also found amongst *P. cochlear*. *P. compressa* and *P. patriarcha* belong to the sublittoral. The former almost exclusively confines itself to the stipes of the kelp, and is fairly numerous though not easily accessible. *P. patriarcha* is rarely seen, being as a rule limited to fairly deep water. Large numbers of *Helcion pectunculus* are to be found in the Balanoid zone, particularly on the shingle beach where they occur both on and under the stones; on the boulders they prefer crevices and hollows. *H. pruinosa* is moderately common on stones near the water's edge, and in the shallower sublittoral channels. *Siphonaria capensis* occurs in small pools in the higher zones, as well as lower down.

3. *Mussels.* *Mytilus crenatus* is the only species of the genus abundant at Oudekraal. Its principal habitat is the ridge of *Vermetus* (see § 4) in the Cochlear zone. Here numbers of mussels live partially embedded in the *Vermetus* tubes, many of them encrusted with barnacles. Small clusters of the mussels are also to be seen filling cracks in the Cochlear zone, and living in the fringe of coral-like lithothamnion which often forms its upper boundary. On the outer rocks the mussels are small and squat, but in more sheltered places they are often very large and completely hidden by small white barnacles. In many places they extend up into the Balanoid zone for some distance.

4. *Other molluscs.* An interesting gastropod at Oudekraal is a species

* Each *P. oculus* as a rule shelters one or more commensal flatworms (*Notoplana ovalis*) between mantle and foot.

† Many of the individuals of *P. cochlear* possess "gardens" consisting of a fine fringe of short *Gelidium* (*G. reptans*?) or of other short algae.

of *Vermetus*, which builds sheets of calcareous tubes along the margin of the sublittoral fringe and in the Cochlear zone. The thickest growth of these tubes occurs about a foot above the level of low water of springs, where it forms a lithothamnion-encrusted ridge along the rocks. On low outer boulders such a ridge forms a rim surrounding the expanses of cochlear mosaic; on higher boulders it marks the upper limit of the Cochlear zone, and forms one of the most outstanding features of the shore, since it persists much nearer inshore than do the *cochlears*, making a conspicuous narrow ridge on rocks and stones (Pl. V). Where the *Vermetus* extends into the mosaic of *P. cochlear* it forms low walls separating the limpets, and gives a very curious appearance to such areas (Pl. VI).

Whelks and periwinkles form a considerable section of the fauna. The large *Argobuccinum argus* is a sublittoral form; *Thais dubia* is typical of the Balanoid zone; *Cominella limbosa* is widely distributed in the damper places; and a smaller whelk (*Pollia lacertina*) inhabits the lower margin of the Littorina zone on the shingle beach. Higher up on the pebble-ridge countless reddish-brown snails (*Marinula tristanensis*) live deep down under the stones. *Littorina knysnaënsis* is present in myriads in the appropriate region, and is often of unusually large size. The most striking of the periwinkles is *Oxystele variegata*, of which large numbers swell the population of the beaches. Although the optimum level of this species is the Balanoid zone, many specimens climb up among the *Littorina* as the tide rises. A curious shell-less pulmonate, *Onchidiella capensis*, forms a constant member of the fauna, and congregates in small fissures and under stones near low-water line. Several species of chiton are abundant on the beaches. *Acanthochiton garnoti* prefers damp positions round the edges of pools, as does *Chiton nigrovirescens*, which, however, can also be found in considerable quantities beneath stones with *Ischnochiton tigrinus* and *Chiton tulipa*.

5. *Tubicolous polychaets.* These form a less important part of the fauna at Oudekraal than in many other parts of the South African coast. *Gunnarea capensis* is the most conspicuous colonial tube-dweller, and is sometimes found cementing together stones in the shallow sublittoral pools. The sandy tubes occur isolated or in small clumps, and do not form large masses as in some other localities. *Spirorbis borealis* is very common in these pools, where its small white tubes are scattered over many of the stones.

6. *Spiders and flies.* Small greyish-black flies, *Telmatogeton minor*, are a familiar sight hovering over the rocks low down on the shore. A grey and red maritime spider, *Desis tubicola*, is also to be seen on damp rocks.

7. *Other common invertebrates, and fishes.* Sea-anemones are particularly conspicuous in the Cochlear and lower Balanoid zones, where

cracks and depressions are often filled with small specimens of the many-coloured *Bunodactis reynaudi*; these also form sheets among limpets or barnacles in places subjected to a considerable amount of splashing, or where water tends to collect. Cracks higher up are the habitat of a smooth dark red species of *Actinia*. Caves and sublittoral channels shelter a variety of brightly coloured forms (*Bunodosoma capensis*, *Pseudactinia flagellifera* and species of *Anthopleura*). Numerous anemones are also found beneath the stones of the shingle beach, where *Anthothoë stimpsonii* and *Halianthella annularis*, among others, live deep down in damp places. Brittle-stars are the most abundant of the echinoderms, for they form an important item in the crypto-fauna; of asteroids, *Asterina exigua* is the most worthy of note, and is very common in the Balanoid zone of the shingle beach and in shallow channels and pools, though it is inconspicuous on account of its small size and uniform greenish-yellow colouring. The orange *Parasterina bellula* and *Echinaster ornatus* are to be seen in various habitats at low levels, but are never present in quantity. An urchin, *Parechinus angulosus*, inhabits crannies in rock pools; it is usually pinkish in colour in this locality. Sipunculids are commonly to be found buried in the substratum of coarse sand and pebbles beneath the shingle, and nemertines are fairly numerous both on and beneath the stones. Of crabs the large *Plagusia chabrus* is almost ubiquitous, while the smaller *Cyclograpsus punctatus* occurs commonly under damp stones at fairly high levels. *Dromidia hirsutissima*, a large hairy pink crab inhabiting the deepest channels, is more rarely seen. The algae harbour multitudes of small crustaceans, many of which are the exact colour of the plants on which they live. Common among the larger species are the isopods *Glyptidotea lichtensteinii* and *Paridotea rubra*. Small fish shelter under stones and seaweed in all the pools, and include *Clinus dorsalis* and *C. superciliosus*, a handsome spotted species, *Marcgravia apiatus*, and the sucker-fish *Chorisochismus dentex*.

Notes on the occurrence of Algae.

The most prominent feature of the shore in this locality is the presence of giant brown algae of the order Laminariales. These seaweeds form extensive fields and forests in the sublittoral area, both off-shore and along the margins of the outer rocks. They extend far inshore in sublittoral channels, in which, however, they are of small size, whereas in deeper water they frequently reach a length of 20 feet (6 metres) or more. The kelp consists principally of *Esklonia buccinalis*, interspersed in places with palm-like clumps of the smaller *Laminaria pallida*. The latter rarely projects above the surface at low water as does the *Ecklonia*, and

so is less conspicuous. On the outer boulders the rock between the holdfasts of the kelp supports varying quantities of other algae, chiefly small fields of red species such as *Epymenia obtusa* and *Botryoglossum platycarpum*, with tufts of *Gelidium cartilagineum*, *Neuroglossum Binderianum* and *Botryocarpa prolifera*, and fronds of the larger *Pachymenia carnosa*. Smaller species, such as *Pterosiphonia cloiophylla*, *Apoglossum ruscifolium* and *Gymnogongrus glomeratus*, are also to be found, particularly towards the upper limits of the region. In sheltered positions the algae are often less dense.

The algae in the margin of the sublittoral fringe where kelp is sparse or absent, vary greatly in amount. In many places *Champia lumbricalis* and *Gigartina stiriata* * flourish, together with smaller amounts of *G. radula*. Higher up the rocks the *Champia* gradually thins out, while the *Gigartina* becomes more plentiful, and dense patches of *Plocamium cornutum* appear in places. The *Champia* and *Gigartina* thus occur in parts of the Cochlear zone as well as below it.

Where the ridge of mussels and *Vermetus* is found, it is typically accompanied by a thin and scanty growth of extremely stunted *Gelidium* (*G. reptans* ?), which sometimes extends on to adjacent rock surfaces. The Cochlear mosaic is in many places remarkably free from algae; occasional small patches of *Caulacanthus ustulatus* occur, with tufts of *Cladophora flagelliformis* and *Iridaea capensis*. The last-named is usually small and dwarfed in this position, but in other habitats the plants become large and very luxuriant. *Caulacanthus ustulatus* has a wide range; patches of it are found as high as the upper parts of the Balanoid zone. *Porphyra capensis* also has an extremely wide range. Its fronds are often small and poor in the upper Cochlear zone, but become larger and more abundant higher up the shore, and are most conspicuous in the Littorina zone, where they form a thick cap on some of the boulders. In most cases these sheets of seaweed consist entirely of a broad-bladed form of *P. capensis*; but when found in the Balanoid zone, they may be composed of a ribbon-like variant of the species. *Splachnidium rugosum* is never common, but isolated plants may attain a considerable length in the Balanoid zone. Two other species typical of this zone are the fringed *Chaetangium ornatum* and the vesicular *C. saccatum*, both of which occur sporadically in the upper parts, forming luxuriant patches on certain rocks and entirely absent from others.

* It is possible that the plants referred to here as *Gigartina radula* and *G. stiriata* may belong, not to two species, but to complexes of related forms (see Setchell and Gardner, 1933). A revision of the South African algae is at present being conducted by G. F. Papenfuss, but he has not yet had the opportunity of comparing our plants with the type specimens, and until his revision is completed, is following De Toni (1897) in treating the plants involved provisionally as belonging to two species; and the same usage has been adopted here.

Two species of encrusting non-calcareous algae are a constant feature of the flora. *Lepadoderma africanum* forms extensive greenish-brown sheets on the rock surfaces in the sublittoral fringe, and is often associated with reddish patches of *Hildenbrandtia pachythallos* and with various pink and mauve lithothamnia. Both these species when found higher up the shore tend to be confined to moist positions and rock pools. Corallines are poorly represented along this part of the coast; small tufts occur in the sublittoral fringe and the Cochlear zone, or sometimes in pools at slightly higher levels; but they are neither plentiful nor varied.

The following account gives some indication of the dense community of algae which lines the shallower sublittoral channels and pools. The floors of these pools consist of small stones and sand which support very few seaweeds. The lower parts of their rocky sides are thinly carpeted with red algae, including *Polyopes constrictus*, *Champia compressa*, *Pleonosporium Harveyanum* and *Dicurella flabellata*, together with some of the species typical of the outer parts of the sublittoral fringe. Higher up the walls are hung with a dense curtain of great fronds of *Gigartina stiriata* and *G. radula*, of which the latter is here by far the commoner of the two species. *G. fastigiata* is also a member of this community, though it is not very plentiful. *Iridaea capensis* reaches its maximum size in this position, where great undulating expanses of it cover the tops of many of the rocks and form a thick fringe just above the curtain of *Gigartina*. Another typical species is *Porphyra capensis*, which grows to considerable size though the fronds are often ragged, and small plants of *Ecklonia buccinalis* are often to be seen.

In the foregoing account of the algae very few green algae have been mentioned, for these are curiously infrequent at Oudekraal. On the open rock *Cladophora flagelliformis* is found in the lower zones, where its green tufts are hardly noticeable amongst the limpets. It also grows in pools at higher levels. *Ulva Lactuca* and species of *Enteromorpha* and *Codium* are to be found, and may be abundant in the shallower channels, but the two former are of very variable occurrence, a profuse growth appearing at times and then disappearing again. Pools high up on the rocks sometimes support large amounts of a light green species of *Enteromorpha*.

Fauna of the lower parts of the Shore.

1. *Deep sublittoral channels and caves.* These clefts lie between the outermost boulders and are always in communication with the open sea. They are often very deep, are in most places difficult of access, and frequently so filled with kelp that it is almost impossible to determine their population. Certain of the channels, however, are so overshadowed

by rocks that they contain little or no kelp, while others are more of the nature of caves.

One such long narrow cleft on examination proved to be fairly typical of the region, and is described below. It is a crevice * lying between two granite boulders and is partially blocked at either end by fallen slabs of rock. The fauna is remarkable for the vivid coloration of many of its members. The stones forming the floor are mottled with purple lithothamnia, and often bear solitary stony corals (*Balanophyllia bonae spei*), orange in colour. The walls are clothed with small red algae (chiefly *Epymenia obtusa*) amongst which live innumerable animals, of which the commonest and most conspicuous are the sponges, which abound near the bottom of these deep channels and often form masses a couple of feet in diameter. These sponges are very seldom exposed to the air even during maximal tides. The largest is *Stelletta agulhana*, which forms grey balls resembling pieces of granite. Others among the more plentiful species are the orange *Lissodendoryx stephensoni*, the brownish yellow *Guitarra fimbriata*, the creamy *Haliclona anonyma*, and a beautiful lilac-blue finger-like sponge, *Callyspongia tubulosa*. Many of these sponges and the surrounding rock surfaces are overgrown with hydroids such as *Sertularella arbuscula* and species of *Eudendrium* and *Tubularia*. At the shoreward end of the pool the rock is patterned with small pink corals (*Corynactis annulata*) and patches of the vivid magenta *Alcyonium fallax*, while throughout the crevice are scattered small corals, variously coloured anemones, white or scarlet gorgonians (*Eunicella papillosa* and *Wrightella coccinea*) and small colonies of ascidians. Errant species, particularly near the water-line, include numbers of hermit crabs (*Paguristes*) and whelks (*Cominella limbosa*, *C. papyracea*, *Argobuccinum argus*, *Fasciolaria lugubris* and *Thais wahlbergi*).

Many of the channels resemble the one just described, but those more completely overshadowed by the surrounding boulders contain a typical cave fauna. In them an even greater profusion of animal life is found, the diversity of corals, gorgonians, anemones, alcyonarians and molluscs being supplemented by many other species of sponges, and by compound ascidians and polyzoa of many kinds, the whole population forming a brilliantly coloured carpet which almost completely hides the rocky walls. The polyzoa are of several different habits. *Emballotheca capensis* and *E. nivea* are encrusting forms; *Retepora tessellata*, *Costazia costazii* and *Chaperia galeata* build coral-like or fan-like colonies; and bushes of softer species, such as *Cellularia infantae*, *C. triseriata* and *Menipea cirrata*, are also commonly seen. Other inhabitants of

* Dimensions: Length 10 feet (3 m.); width 1 foot (0·3 m.); depth 2–3 feet (0·6–0·9 m.).

these caves are crabs of various species, crayfish (*Jasus lalandii*), nudibranchs and starfish.

2. *Shallow sublittoral channels.* These channel-pools lie between the main groups of boulders and the beach, and are fairly shallow, seldom being more than a foot (0·3 m.) in depth at low water of springs. They are of considerable extent, with a substratum composed of rounded stones resting on coarse sand, and are all interconnected, communicating with the deeper channels and the open sea even during maximal tides. During tides of exceptional amplitude some of them become almost drained of water for a time.

All these channel-pools support a great profusion of algae, which has already been described. The smaller stones which floor the pools are free from such growths of leafy algae, but are largely covered with pink or purple lithothamnion or with a green slimy coat of lichens and diatoms, and in many cases are also sprinkled with the small white tubes of *Spirorbis borealis*. The animals living on the upper surfaces of the stones and rocks are chiefly molluscs, of which the limpets *Patella granatina*, *P. miniata*, *P. oculus* and *Helcion pruinosa* form the greater proportion. Other animals frequently encountered here are *Mytilus crenatus*, nudibranchs, starfish, crabs, and in the deeper parts *Corynactis annulata*. Near the water's edge *Acanthochiton garnoti* and an orange-red ascidian (*Aplidium schultzei*) are commonly found.

It is, however, beneath the stones that the greater part of the animal life of these pools is to be discovered, for they harbour a cryptofauna which is both abundant and varied, and of which the following list gives but an outline. Small molluscs, worms and echinoderms are all exceedingly common, while the stones themselves are in many cases encrusted with polyzoa (*Mucronella contorta*, *Cribrilina inermis*), with pink, fawn, or orange sponges (*Aplysilla rosea*, *Haliclona ciocalyptioides*, *H. anonyma*, *Hymeniacidon sanguinea*) and with colonies of compound ascidians, and are overrun by small isopods (*Exosphaeroma kraussii*, *Parisocladus perforatus*) and other crustaceans. The molluscs include *Oxystele zonata*, *Gibbula rosea*, *G. capensis*, *Marginella biannulata*, *Turbo cidaris*, *Ischnochiton tigrinus*, *Chiton tulipa*, the fissurellid *Diodora mutabilis* and the ormer *Haliotis sanguinea*. The commoner polychaets are *Euphrosyne capensis*, *Audouinia filigera*, *Cirratulus chrysoderma*, *Nicolea macrobranchia* and the polynoid *Lepidonotus semitectus*. Small brittle-stars (*Amphiura capensis*, *Ophiothrix triglochis*, *Amphipholis squamata*) are remarkably plentiful, and may often be picked up by the handful when stones are overturned. The pink urchin *Parechinus angulosus* is common, and holothurians (*Thyone serrata*, *Cucumaria insolens* and *C. discolor*) are also to be found. Other species are pink and white brachiopods

(*Kraussina pisum*), pycnogonids (*Discoarachne brevipes*) and crabs of several species.

3. *The epiphytes and epizoa of the kelp.* The giant Laminarians, in particular *Ecklonia buccinalis*, form a place of attachment for many animals and algae. The stipes of the older kelp plants are often infested with epiphytic algae, from which young plants are usually free. Mossy growths of species of *Ectocarpus* and *Enteromorpha* form a green coating over many of the stipes, to which are also attached bushes of the red epiphytes *Suhria vittata*, *Carpoblepharis flaccida* and *Polysiphonia virgata*, which may in their turn bear soft feathery tufts of *Pleonosporium purpuriferum*. Colonies of vivid pink hydroids (a species of *Tubularia*) clothe the lower parts of many stipes, and the limpet *Patella compressa* is sometimes to be seen, especially on the subterminal expansions of the stipes. The long fronds are in many cases covered with a delicate tracery of small colourless hydroids (*Plumularia setacea* and *Obelia geniculata*). It is, however, the holdfasts of the plant which yield the most interesting section of the population; they form an ideal habitat for a large community of animals since they give adequate protection and yet permit currents of water to circulate freely through them. The tubicolous polychaet *Spirorbis borealis*, encrusting polyzoa, as well as hydroids, are attached to the holdfasts, while within the shelters formed by their interlocking subdivisions live countless small animals of which examples must suffice. The sponges include soft diffuse forms and sycons (*Iophon proximum*, *Oscarella lobularis*, *Leuconia crambessa*), and these together with compound ascidians line the small hollows among the subdivisions; these hollows also afford protection to various nemertines, such polychaets as *Eulalia viridis*, *Platynereis dumerilii*, *Syllis variegata* and other smaller species; and small crustaceans (*Ceradocus rubromaculatus*, *Maera inaequipes*, *Aora typica*, *Dynamenella ovalis*, *Polycheria atolli*, etc.). Small molluscs include *Helcion pruinosa*, small bivalves and minute whelks. In addition mats of encrusting polyzoans (*Holoporella capensis*, *Mucronella contorta* and others) are often to be found, while pycnogonids, alcyonarians, brittle-stars and sea-anemones also avail themselves of this refuge.

The Rocks at Lui Bay and Geld Kist.

The examination of these rocks served to confirm the account of the population and its arrangement in zones which has been given for Homestead Rocks. Local variations were, of course, apparent, but these were on the whole of minor importance. Perhaps the most noteworthy difference at Lui Bay was a stronger development of *Gunnarea capensis* than at Homestead Rocks. At Geld Kist the granite island is separated from the

shore by a fairly wide and sheltered channel, in which there is a considerable growth of the Laminarian *Macrocystis pyrifera*, with fronds up to 15 or 20 feet (5 or 6 m.) long, in addition to *Laminaria* and *Ecklonia*. The *Macrocystis* along this coast tends to appear in the more sheltered parts of the sublittoral zone. Another feature of the Geld Kist rocks is that the fauna of the sublittoral pools and channels is on the whole less rich in species than at Homestead Rocks.

Discussion.

The points of general importance which are brought out by this paper can be emphasised much more profitably after a second area on the west coast has been described. An account will shortly be completed of the intertidal region in the Port Nolloth district, near the northern extremity of the west coast of the Union, and after this has been presented some of the leading features of the biota of the two localities will be discussed.

Summary.

A description is given of rocky areas in the intertidal region in the neighbourhood of Oudekraal, a locality situated on the northern part of the west coast of the Cape Peninsula, and affected by cold inshore water. The intertidal belt here is subdivided for descriptive purposes into four zones, from above downwards the Littorina, Balanoid and Cochlear zones, and the sublittoral fringe. The sublittoral region is characterised by the presence of a strongly developed Laminarian belt, dominated by *Ecklonia buccinalis*.

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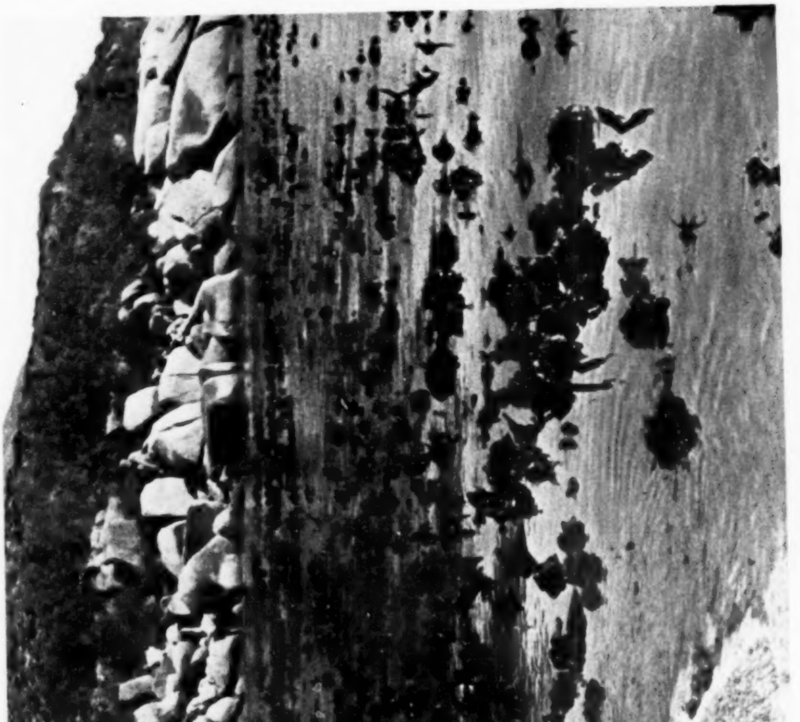

The shore at Oudekraal, looking southward from Homestead Rocks; showing granite boulders and a field of *Ecklonia buccinalis*.
From a photograph by G. J. Broekhuysen.

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Oudekraal. A granite boulder, showing the position of the Vermetus zone, following the waterline.
From a photograph by G. J. Broekhuysen.

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The Cochlear zone, Kommetje (Atlantic coast of the Cape Peninsula, south of Oudekraal); specimens of *Patella cochlear* situated in crater-like depressions. The ridges bounding the craters are formed by *Vermetus* tubes and lithothamnion, and the floor of each crater represents the habitual browsing-area of the limpet, on which the formation of the tubes is inhibited. There are small limpets on the backs of the larger ones, a feature characteristic of crowded parts of this zone. From a photograph by T. A. Stephenson.

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THE SOUTH AFRICAN INTERTIDAL ZONE AND ITS RELATION TO OCEAN CURRENTS.

III.—An Area on the Northern Part of the West Coast.

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(With Plates VII–IX, and two Text-figures.)

(Read May 19, 1937.)

CONTENTS.

Introduction.

A paper appears in the present issue of this Journal (pp. 49–65), which describes the biota inhabiting rock surfaces in the intertidal region at Oudekraal, a locality situated on the southern part of the west coast of the Union of South Africa. The following paper presents the results of a further survey on the same coast; this was carried out in the neighbourhood of Port Nolloth, near the northern boundary of the Union. These surveys form the second and third members of a series directed by Prof. T. A. Stephenson, of the Department of Zoology, University of Cape Town, in which the influence of cold and warm currents on the biota of the South African coasts is being investigated. Port Nolloth, like Oudekraal, lies on the part of the coast affected by the cold Antarctic intermediate water.

In the survey of the Port Nolloth district the field-work was accomplished during a three-weeks visit in October and November 1935. I wish

to thank E. J. Eyre, M.Sc. and Anne Stephenson for assistance during this visit; Dr. G. J. Broekhuysen for the photographs reproduced in Plates VII and VIII; and Prof. Stephenson for his guidance throughout the work. I also wish to acknowledge my further great indebtedness to the various specialists who have identified the material collected during the survey, and whose names have appeared in the first and second papers of this series (Stephenson, Stephenson and du Toit, 1937, p. 349; Bright, 1938, p. 50). A paper referring to Port Nolloth (and other) material from our collection has been published by Monro (1937).

Description of the Locality.

The village of Port Nolloth (Lat. 29° 15′ S., Long. 16° 52′ E.) faces the Atlantic Ocean in the north-west corner of the Union of South Africa. It lies on the coast of Namaqualand in the Cape Province, some 55 miles (89 km.) south of the mouth of the Orange River, and 460 miles (740 km.) by road from Cape Town.* The village itself is built on and mainly surrounded by deposits of sand, but there are rocky outcrops of considerable extent on the foreshore. These outcrops, interrupted at intervals by small sandy beaches, stretch along the coast for many miles in both southerly and northerly directions. The village possesses a quay, visited by fishing-boats and small coasting steamers, but their presence does not appear to pollute the water for any appreciable distance. On calm days a small amount of oil may be seen collected along the edge of the rocks which lie nearest to the quay, but those farther off appear to be free from any trace of it.

A general survey of the shore in the neighbourhood of Port Nolloth itself was carried out, and a supplementary survey was made of the rocks at Cliff Point, a place situated approximately 15 miles (24 km.) by road to the north of Port Nolloth. A visit was also paid to the shore at Buchuberg, though a detailed examination could not be made there owing to the short time available and the state of the tides, which were of minimum amplitude. Buchuberg lies beyond Cliff Point, some 46 miles (74 km.) by road from Port Nolloth, and is the most northerly point included in our surveys of the west coast of the Union.

Fresh water has little or no influence on the parts of the Namaqualand coast which were studied in this survey. The Orange is the only river which contains water throughout the year, and this lies too far north to affect the biota of the areas investigated. Other streams are very few in number and flow only at infrequent intervals, while springs and marshes are absent owing to the dryness of the climate.

* Distances have been taken from the R.A.C. Route Book for 1936.

THE ROCKS AT PORT NOLLOTH.

In order to obtain a comprehensive picture of the animal and plant populations of the intertidal region, several different areas of rock were studied in the immediate vicinity of Port Nolloth (fig. 1). These are composed of pre-Nama quartzites and schistose rocks, and are hard, light brown

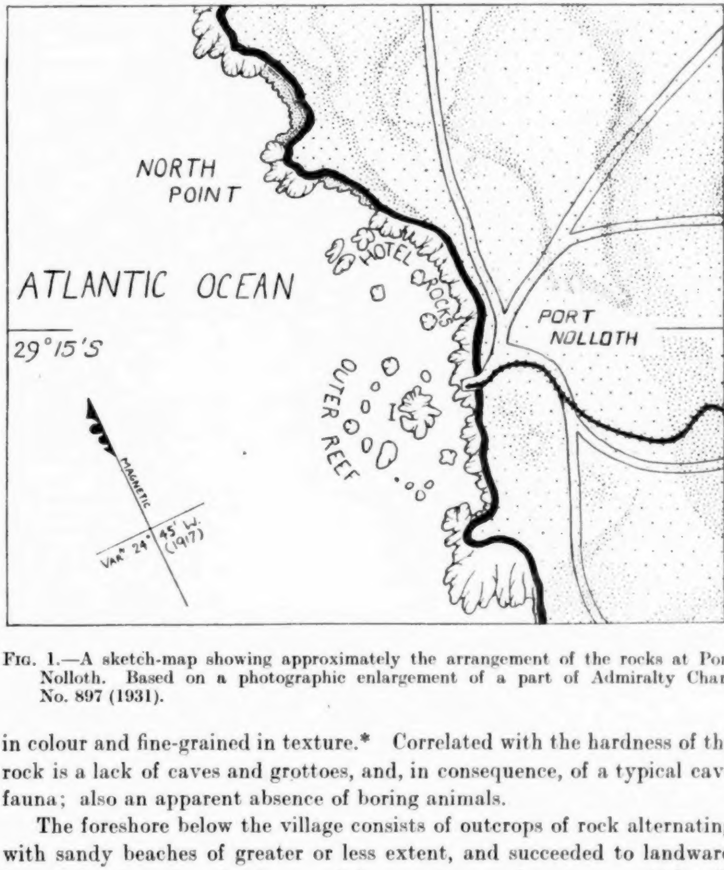

FIG. 1.—A sketch-map showing approximately the arrangement of the rocks at Port Nolloth. Based on a photographic enlargement of a part of Admiralty Chart No. 897 (1931).

in colour and fine-grained in texture.* Correlated with the hardness of the rock is a lack of caves and grottoes, and, in consequence, of a typical cave fauna; also an apparent absence of boring animals.

The foreshore below the village consists of outcrops of rock alternating with sandy beaches of greater or less extent, and succeeded to landward by a belt of sand or by low sand-dunes. One such outcrop, which will be called "Hotel Rocks," stretches northwards from the village quay to the lighthouse. In this region the shore presents a curious appearance,

* I am indebted to Dr. A. W. Rogers for this information.

consisting of long ridges of rock which run parallel to the coastline and which typically slope steeply to seaward and present a vertical or overhanging landward face.* Animals living on the landward overhang of such a ridge are therefore much better protected from the waves than those on the seaward face. The ridges are separated from one another by channels, of which those in the lower part of the shore are at all times filled with water and in communication with the open sea, whereas those higher up are dry (except for shallow isolated pools) at low water. At high water all the channels are wave-swept, while the outer ridges are completely submerged and their positions only indicated by lines of surf.

About a mile † (1·6 km.) to the north of the village, separated from the Hotel Rocks by a stretch of sand, lies an extensive rocky promontory known as North Point. The same type of rock-formation occurs in this region, but here the ridges, which often form broad high platforms, lie at right angles to the shore and are subjected to very strong wave-action.

Near the Hotel Rocks, some 300 yards (275 metres) to seaward of the quay, is situated a small island (fig. 1, I). It is easily reached by boat, and at low water appears as an acre or more of low rocky outcrops surmounted near the northern end by a large mound of sand and shell. This mound is the only part left uncovered at high water of springs. The Island and the Hotel Rocks are to some extent protected from the force of the waves by a low-lying offshore reef which extends in a broken line from a point opposite the lighthouse in the north, southwards past the Island. Over this reef (which will be referred to as the Outer Reef) the seas break continuously except in unusually calm weather. This reef partially encloses a fairly well sheltered lagoon in which, although the waves are still quite large, they are by no means as strong as those on the unprotected parts of the coast such as North Point. The lagoon has a sandy bottom on which boulders overgrown with kelp are scattered.

The area examined in most detail was the Hotel Rocks; but the observations made there were confirmed and supplemented by less extensive studies of the Island, the Outer Reef, and North Point.

As at Oudekraal, the rock surfaces in the intertidal region may be divided into three zones, each of which is characterised by the presence of certain animals and algae. At Port Nolloth, as elsewhere, these zones grade into one another, their boundaries seldom being sharply demarcated, and also vary considerably in nature according as the amount of splash and wave-action differs from place to place. The subdivision into zones

* A cross-section of the shore in this region is given in fig. 2. The measurements were made with a surveyor's tape.

† These distances are only approximate, since no facilities were available for accurate determinations.

is less obvious at the Hotel Rocks than in the other areas, owing to the configuration of the shore; certain of the zones, however, may be clearly distinguished on each ridge, so that by taking the ridges together a complete picture of the zonation may be obtained. At Hotel Rocks large pools are few in number, such small pools as occur on the ridges frequently harbouring a community which corresponds in general with that of the open rock, though often denser and more varied. Extensive pools with a very rich population are found on the Island, and interesting pools also occur at North Point.

In the course of the surveys hitherto carried out at other points on the South African coast, it has been found that from Durban along the eastern and southern coasts to False Bay, and on at least part of the west coast, it is possible to divide the intertidal belt for descriptive purposes into at least three principal zones—Littorina zone, Balanoid zone and Sublittoral Fringe; and a fourth belt, the Cochlear zone, is distinguishable along the greater part of this region. In the case of Port Nolloth a difficulty has arisen. In the first place the Cochlear zone is absent, and is replaced by a belt inhabited by *Patella argenvillei*; but since *P. argenvillei* does not, so far as we can determine, extend to as high a level as *P. cochlear* would reach if present, the correspondence between the two zones is partial and not exact. Secondly, the sublittoral fringe and the Littorina zone can be recognised at Port Nolloth as elsewhere; but between the Littorina zone and the zone of *Patella argenvillei* there remains a region for which it is not easy to find a suitable name. There is no doubt that the region in question corresponds approximately to the Balanoid zone of the major part of the South African coast, and that it can be subdivided, as elsewhere, into levels corresponding to the upper and lower Balanoid zones; the difficulty arises from the fact that only the lowest part of the zone is at all extensively populated by barnacles, which are scarce or absent at the higher levels. We think that in spite of this fact it would be confusing rather than otherwise to create a new term for this zone at Port Nolloth, and we propose consequently to refer to it as the Balanoid zone so that our terminology for the whole coast may be as uniform as possible.

I. *The sublittoral fringe.* As at Oudekraal, the sublittoral zone proper is occupied by a community of Laminarians, which invade the sublittoral fringe to a certain extent (a similar region is illustrated in Plate VIII). Along the upper edge of this zone the kelp plants are relatively small and interspersed with other algae. The tunicate *Pyura stolonifera* ("redbait") is commonly to be found in the fringe. In some places these ascidians form a narrow belt of closely packed individuals, in others only small clumps or solitary individuals are to be seen. A curious exception to the normal occurrence of *Pyura* is found on the Island, where the redbaits are present

at higher levels than usual on ledges where water tends to collect. The sublittoral fringe is only accessible at low water of maximal tides, at which time it is uncovered only between waves, unless in exceptionally calm weather. The redbaits are not easily distinguished as their tests are frequently overgrown with lithothamnion and small algae of other types.

The sublittoral region is most easily examined in the deep outer clefts of the Outer Reef and North Point, where a selection of brightly coloured sponges, sheets of compound ascidians of various species, bushy polyzoa and a variety of small red algae commonly coat the rocks between the holdfasts of the kelp. Of other animals *Dasychone natalensis*, a handsome polychaet with mauve or reddish fans, is often associated with the redbaits, while a large brown-and-white whelk (*Argobuccinum argus*) inhabits the channels, in which large crayfish are also of frequent occurrence.

II. *The zone of Patella argenvillei* (Pl. VII, fig. 2). The zone immediately above the fringe, which is exposed for a time during the stronger but not during the weaker tides, is dominated in the more seaward positions by a large limpet, *Patella argenvillei*. Great numbers of these limpets occupy a very clearly defined region which includes the lower parts of the rocks up to about the limit of the splash zone at average low water of springs; above this level they are seldom seen except in pools. The limpets often reach a great size, many of the larger individuals being overgrown with pinkish lithothamnion and clumps of small barnacles, and crowned with bushes of corallines and other algae, so that they give a curious and very characteristic appearance to the rocks. The adults commonly bear one or more younger limpets on their shells. Between the limpets the rock is often coated with lithothamnion or with non-calcareous encrusting algae, whilst corallines and tufts of leafy red algae are also of common occurrence. In the lower parts of the area, which are much splashed or over which water drains continually, these bushy algae may form a dense carpet in which the limpets are almost hidden from view.

At low water of springs on a moderately calm day most of the *P. argenvillei* are uncovered for a limited period, varying according to their position in the zone, but even during this time are washed by almost every swell. At low water of neaps the zone remains completely submerged.

III. *The Balanoid zone.* Barnacles are present in comparatively small numbers along this coast, and the zone above the *Patella argenvillei* is perhaps most distinctly characterised by the presence of the limpet *Patella granularis*, large numbers of which occur in this region all along the shore. The zone falls naturally into two subdivisions: of these the lower is the more densely and variably populated, while the upper is everywhere occupied by a sparse but relatively constant fauna.

(a) *Lower Balanoid zone.* At the Hotel Rocks open rock surfaces in this region support a singularly scanty fauna in which *P. granularis* is the most frequent species, though various other molluscs are also common, including *Mytilus* in small numbers. Algae are scarce; such species as are found are short and moss-like except at the lower margin of the zone, where a fringe of brownish algae (*Iridaea*, *Porphyra*, *Gigartina*, *Leathesia*, etc.) is a prominent feature. A population of this constitution is confined to the more sheltered areas. Increased exposure to the surf is often accompanied by a much greater development of mussels, of which an extensive community covers large expanses of rock. On the Island this community consists principally of *Mytilus crenatus*, of which large clumps almost hide the rocks. At North Point the blue-black *Mytilus meridionalis* is also to be found, though uncommon except in pools, and on the Outer Reef the extraordinarily dense carpet of mussels consists of both species. *Mytilus crenatus* commonly occupies the upper parts, while lower down it is partially ousted by masses of *Mytilus meridionalis*, which at this level becomes the commoner of the two species. Luxuriant growths of a diversity of algae frequently accompany the mussel-beds, covering them with so thick a turf as almost to obscure them from view. Among these algae *Champia lumbricalis* and species of *Gigartina* are conspicuous. Other characteristic inhabitants of the lower Balanoid zone are the tube-building polychaets *Gunnarea capensis* and *Dodecaceria fistulicola*, both present in moderate amounts. Among the mussels anemones are very plentiful, often forming many-coloured sheets in shallow pools, the principal species being *Bunodactis reynaudi* (Pl. VII, fig. 1) and a species of *Anthothoë*.

(b) *Upper Balanoid zone.* Rock surfaces in this sub-zone offer a great contrast to those lower down, for the fauna is scanty, and animals are on the whole small, soberly coloured and inconspicuous, while algae are represented by a few short moss-like species (*Caulacanthus*, *Cladophora*, etc.). *Patella granularis* reaches a large size here, and other animals which are notably plentiful are the small limpet *Helcion pectunculus* and the periwinkle *Oxystele variegata*. In some places, as at North Point, large numbers of *Siphonaria capensis* inhabit the uppermost parts of the zone.

The Balanoid zone remains entirely exposed for some hours during maximal tides; during minimal tides the lower parts are splashed or submerged, particularly in rough weather. The entire zone is submerged for a considerable time at high water.

IV. *The Littorina zone.* The Littorina zone occupies the highest and driest parts of the intertidal belt and overlaps into the supralittoral area. This zone remains completely exposed for considerable periods during both maximal and minimal tides, and in it a small snail, *Littorina knysnaënsis*, occurs in vast numbers. The zone occupies the highest parts of

the ridges at Hotel Rocks and North Point, but is absent from the other two areas as they contain no rocks of sufficient height above the sea. Few other animals, and as a rule only one alga (*Porphyra capensis*), which is very erratic in its distribution, are found on the open rock in the Littorina zone, though an assortment inhabit the pools. A colourless amphipod, *Talorchestia capensis*, infests patches of sand in this region and the decaying kelp with which they are often littered.

Tide levels. An attempt was made to obtain some indication of the relative amounts of exposure to which the several zones are subjected, at Hotel Rocks, during both spring and neap tides, by noting the time and order of appearance of some of the commoner and more prominent animals during a period of 8 or 9 hours, on each of two days. The times obtained are very approximate, since the sea was never very calm, nor were vertical rock faces available for taking exact measurements. The observations made are given below for comparison with those obtained at Oudekraal and elsewhere.

28th October, 1935 (*one day after new moon*).

Argenvillei zone. The upper parts of this zone were splashed at low water, while the lower parts only emerged between waves. The exposure of the upper parts lasted from 16–20 per cent. of the tidal period, while the lowest parts appeared during less than 8 per cent. of that period.

Balanoid zone. The lowest animals in the zone were splashed even at low water; the rest remained dry for considerable periods. The time during which the zone was uncovered varied from 20 per cent. to 58 per cent. of the tidal period, according to level on the shore.

Littorina zone. This was completely exposed and dry at low water; at high water almost all the snails were submerged, even the topmost ones being in the splash. None remained dry. The animals were exposed for 58–83 per cent. of the tidal period.*

2nd November, 1935 (*six days after new moon—tides almost minimal*).

Argenvillei zone. Completely submerged even at low water.

Balanoid zone. At low water the lower part of the zone, containing *Patella granatina* and much of the *Gunnarea capensis*, was submerged or continually wave-washed. The zone remained uncovered for a time ranging between 0 per cent. and 84 per cent. of the tidal period.

Littorina zone. At low water all the individuals of *Littorina* were left dry, while at high water the zone was almost completely washed or splashed, though much of it was visible between waves. The time of exposure varied between 84 per cent. and 100 per cent. of the tidal period, for a few of the snails remained dry throughout the entire period.

* It may be noted that if the rocks at this locality had been higher, a proportion of the periwinkles would probably have been out of reach of the splash.

Further Notes on the occurrence of particular Animals.

1. *Barnacles.* These do not constitute a large proportion of the population. The only species which appears to be plentiful is *Chthamalus dentatus*, which is very unevenly distributed; when present, its chief habitat is low down on the shore either among the *Patella argenvillei*, whose shells it often encrusts, or attached to mussels in small runnels of water between them. The larger species, *Octomeris angulosa* and *Tetraclita serrata*, appear to be relatively scarce at Port Nolloth, and, so far as we were able to discover, are confined to small moist crevices and other sheltered positions. The giant barnacle *Balanus maxillaris* is sometimes to be seen in the lower zones.

2. *Limpets.* Seven species of *Patella* are found at Port Nolloth, at least six of which form a conspicuous part of the fauna. The species whose range extends farthest up the shore is *Patella granularis*; next comes *P. granatina*; then *P. barbara* and *P. miniata*, and finally *P. argenvillei*. *P. patriarcha* is rarely found, and belongs exclusively to the sublittoral, as does *P. compressa*, the latter being confined to the stipes of the kelp plants. Although the species appear in this order they do not form separate zones, but overlap to a considerable extent. *P. granularis* has a wide area of distribution which ranges from the lower fringe of the Littorina zone as far as the Argenvillei zone. *P. granatina* is extremely common all along the shore; the individuals are of large size, and most abundant in the lower Balanoid zone, occurring especially in situations such as the leeward side of rocks and the tops of stones in shallow channels, though they may inhabit pools up to high levels. *P. barbara* is plentiful all along this coast, and shows a marked tendency to live entirely submerged, seeming to flourish best in calm water. It commonly lives in sublittoral channels and pools, and more rarely on wave-washed rock faces. In such positions it outnumbers *P. granatina*, but it does not extend very far up the shore. The individuals are large, and commonly covered with lithothamnion and worm-tubes. *P. miniata* is not uncommon, living in similar situations to *P. barbara*. Besides these *Patellae*, another genus of Patellids occurs. *Helcion pectunculus* is conspicuous in the upper parts of the Balanoid zone, particularly in hollows and crevices. *Helcion dunkeri* is widely distributed in channels and damp places at most levels on the shore, but is nowhere very common. *Siphonaria capensis* (a pulmonate) is notably abundant in and around pools in the higher zones.

3. *Mussels.* *Mytilus crenatus* and *M. meridionalis* both reach their maximum density in the lower Balanoid zone, where they form tightly packed fields on many of the rocks. The typical mussel of the *Mytilus* zone along the south coast, *Mytilus perna*, was not found.

4. *Tubicolous polychaets.* Two species of tube-building worms form a prominent part of the fauna. The more abundant of the two is *Gunnarea capensis*, whose sandy tubes form clumps or thin sheets in the Argenvillei and lower Balanoid zones. This worm often builds extensive rounded masses of tubes on the isolated clumps of rock which stand up at intervals along the sandy beach between the Hotel Rocks and North Point. The other noteworthy tubicolous species is *Dodecaceria fistulicola*, which in places forms a ridge of limy tubes along the lower border of the Balanoid zone, and is also found in small mounds among the mussels. Its tubes and the adjacent rock surfaces are almost invariably encrusted with lithothamnion. *Spirorbis borealis* is also fairly common but is inconspicuous; it often covers limpet shells and stones low down on the shore.

5. *Other common invertebrates, and fishes.* Sea-anemones are abundant locally, typically belonging to the fauna of channels or pools, though considerable sheets of *Bunodactis reynaudi* occur on wave-washed ledges. Among Echinoderms, *Parechinus angulosus* is a common inhabitant of pools and channels in some of the rocky areas; and a small brittle-star (*Amphiura capensis*) is conspicuous among the animals under stones. The commonest star-fish is *Asterina exigua*, invariably of a dirty olive-green colour and especially frequent in pools high up on the shore.

The common snail-shaped gastropods of the shore include a series of species rather different from that which prevails along the southern coast of the Union, the series already described as occurring on the shore at Still Bay (Stephenson, Stephenson and du Toit, 1937). Some of the common south coast species are present and plentiful; others appear to be absent; and species possibly not represented on the south coast are present also. Among the apparent absentees the most notable are *Oxystele sinensis* and *O. tigrina*, species extremely abundant on the south coast. *Littorina knysnaënsis* and *Oxystele variegata* are very plentiful at high levels; *Thais dubia* is found at both high and low levels. *Cominella delalandii* is almost ubiquitous in damp places, and *C. papyracea* inhabits the lowest zones and is commonly encrusted with a dark purple polyzoan. *Thais cingulata* is abundant in some places, especially among mussels; and the small bluish *Tricolia kraussi* is fairly common in pools and channels.

A small chiton (*Ischnochiton elizabethensis*), varying in colour from white to greyish-black, is abundant on and under stones. Among crabs, *Plagusia chabrus* is a common species, while the smaller *Cyclograpsus punctatus* is a familiar inhabitant of the upper pools on the shore. Of fish found in pools the most common are probably the small *Clinus acuminatus*, *C. superciliosus* and *Gobius nudiceps*, whilst shoals of small fry such as *Mugil capito* are often seen in channels.

Notes on the occurrence of Algae.

The algal flora of the Port Nolloth district is characterised in the first place by the presence of a conspicuous Laminarian zone, occupied by the two giant species *Laminaria pallida* and *Ecklonia buccinalis.* So far as it was possible to determine, the *Laminaria* is by far the commoner of the two species, the specimens of *Ecklonia* being of relatively occasional occurrence.

Secondly, apart from the Laminarians the flora includes several species capable of growing into large plants. Further, the algae often completely cover the rocks in great profusion for considerable distances along the shore, frequently forming a dense and very coarse turf in the Balanoid and Argenvillei zones. Another interesting feature is the great quantity of epiphytes, particularly on the larger algae.*

In the wave-swept areas of the lowest zones the *Laminaria* may cover as well as surround the rocks, but very frequently the coarse turf mentioned hides the rock altogether. Such a turf is particularly characteristic of parts of the Argenvillei zone and of the *Mytilus* belt, and, although varying in constitution from place to place, commonly contains some or all of the following species: *Champia lumbricalis, Plocamium cornutum, Caulacanthus ustulatus, Gigartina fastigiata,* short plants of *G. radula* and *G. stiriata, Cladophora flagelliformis, Bryopsis setacea, Leathesia difformis, Iridaea capensis, Porphyra capensis, Centroceras clavulatum* and corallines.

The *Laminaria* and *Ecklonia* are the largest and most conspicuous forms, but there are also several other very striking types. *Porphyra capensis* grows to a large size, frequently entirely covering low-lying isolated rocks, and making long fringes around the edges of the deeper pools, as well as occurring at higher levels. Elsewhere the long ribbons of *Schizymenia undulata* often surround the pools. *Gymnogongrus vermicularis* sometimes covers the rocks in sheets, and *Iridaea capensis* displays its extensive folds in pools and channels. Other forms which are ubiquitous, if not so spectacular in appearance, in the lower pools and channels, are firstly *Codium fragile,* which is very often so covered by epiphytes as to be quite hidden, and secondly *Chordaria capensis,* which is also plentiful right up to the pools in the highest regions.

Amongst so many red or brown seaweeds the few green ones present are very conspicuous. In pools at high levels green hair-like species of *Cladophora* are very common, and also a fair quantity of *Enteromorpha.* A soft green hair-like weed (*Urospora media*) grows plentifully on certain inshore rocks. A little lower, *Ulva Lactuca* makes its first appearance in

* These epiphytes include *Pleonosporium purpuriferum, Pterosiphonia cloiophylla, Ceramium rubrum, C. cancellatum, Polysiphonia virgata, Suhria vittata, Ectocarpus siliculosus, Porphyra capensis,* etc.

small patches, and other types of fine green weed, such as *Cladophora flagelliformis* and *Bryopsis setacea*, grow in long streamers in the deeper channels, their greatest length and abundance being reached in the lowest regions of the shore.

Corallines and lithothamnia are to be found in all the lower parts of the beach, but extend to higher levels in pools than they do on open rock. The corallines of the higher areas are short and stunted, and the lithothamnion is often pale and thin, except where it makes a petal-like formation on stones in the pools. In the lower zones it stretches in great sheets of definite colour, sometimes hidden by kelp, and here the corallines are long and feathery, and often form one of the components of the turf previously mentioned. The shells of the limpets of the lower zones are frequently crested with corallines and may be covered with lithothamnion as well.

Some idea of the types of algae occurring in the various zones of the beach is given by the following descriptions of pools in several areas at Hotel Rocks.

In the inshore regions, which are uncovered at low water of all tides, there are roughly three kinds of pool. The smallest, mere cracks in the rock, contain only lithothamnion and *Chordaria capensis*; in larger crevices corallines and the bluish-green *Cladophora flagelliformis* are also present. One large pool contained all the algae mentioned above together with *Enteromorpha*, a little *Leathesia difformis*, and a mossy species of *Cladophora* which concealed numerous specimens of *Asterina exigua*. The rocks bounding the pool were fringed with *Schizymenia undulata*.

Towards the middle of the shore, in a pool from 18 inches to 2 feet (0·5–0·6 m.) deep, the algae were both numerous and well grown. *Chordaria capensis*, long streamers of *Cladophora flagelliformis* and much epiphytised *Codium fragile* were attached to the rocks around the pool, and often floated over the entire surface of the water. Below them were shorter algae, often in tufts, such as *Plocamium rigidum*, *Gigartina fastigiata*, *Bryopsis setacea*, *Pleonosporium Harveyanum*, and a species of *Cladophora*. The stones at the bottom of the pool were often coloured pink with lithothamnion and much overgrown by corallines.

In the sublittoral pools and channels, which may reach a depth of 3 to 5 feet (0·9–1·5 m.), the algae are the most luxuriant. The marginal growth is greater, containing not only the forms fringing the pools of the middle region, but also *Porphyra capensis*, *Iridaea capensis*, *Centroceras clavulatum* and *Laminaria pallida*. The epiphytes on the *Laminaria* and *Codium* are particularly long and varied. Amongst the algae in the deeper parts are *Chaetomorpha clavata*, *Pterosiphonia cloiophylla*, *Apoglossum ruscifolium*, *Ceramium rubrum*, *Botryoglossum platycarpum* and others. The stones lying at the bottoms of such pools often bear a good growth of

corallines, the green algae *Bryopsis setacea* and *Cladophora flagelliformis*, and also a quantity of colonial diatoms. Other species fairly or very common in these channels are *Champia lumbricalis*, *Gigartina radula*, *G. stiriata*, *Grateloupia filicina*, *Suhria vittata*, *Schizymenia obovata*, *Botryocarpa prolifera*, *Leathesia difformis*, *Chordaria capensis*, *Pleonosporium Harveyanum*, and *Anisocladus congestus*.

The Rocks at Cliff Point.

The shore at Cliff Point presents a very different aspect from that seen in the environs of Port Nolloth, since it is bounded by perpendicular rocky cliffs from 50 to 70 feet (15 to 21 metres) in height. The cliffs have been much eroded by the sea, so that they form an irregular coastline with many bays and promontories. Below them the shore varies greatly. In some places deep water may extend right up to the base of the declivity, rendering it entirely inaccessible, while in others there are wave-cut platforms and fallen rocks which can quite easily be examined. In such places deep channels and gullies run up between the rocks, whose population is continually exposed to the action of heavy seas. In some of the bays, however, conditions are very different. In the one examined the shore is almost flat, and a very wide, almost imperceptibly sloping stretch of low rocks is separated from the cliffs by a broad sandy beach. On these flats the rocks are cut up into small islands and platforms by a network of fairly deep channels. The rock formation appears very different from that at Port Nolloth, the quartzites being accompanied by a broad band of conglomerate in which large water-worn pebbles are embedded in a fine sandy matrix. The rocks forming the flats consist almost entirely of the fine-grained quartzites, and form a belt from 150 to 200 yards (140 to 180 metres) wide along a considerable part of the bay. The sandy beach between them and the base of the cliff is about 40 yards (37 metres) in width; both flats and beach are covered by the sea at high water.

The same zones are present here as at Port Nolloth, but various minor differences are noticeable. The zones may be most clearly distinguished on the flats, owing to the presence there of certain animals in overwhelming numbers, to which the unusual appearance of this region is mainly due. The description which follows refers to the conditions obtaining on such flats. The fauna of the steeper parts of the shore is of the same type, but there some of the animals are much less plentiful, so that the zones lack the dominant communities so characteristic of the flats.

A very rich growth of kelp is present in the sublittoral area, and as elsewhere at Port Nolloth it consists almost entirely of *Laminaria pallida*, though a few plants of *Ecklonia buccinalis* are to be seen. The Pyura

community is poorly developed, though a few redbaits are often present among the holdfasts of the kelp in the sublittoral fringe, and in shallow pools a short distance above it.

An Argenvillei zone of the same type as at Port Nolloth itself is found, and occupies a similar position on the shore.

Possibly owing to the width of the flats, two dominant communities of animals occupy the lower Balanoid zone. These are very extensive and exceedingly well-defined. The outermost rocks and the sides of some of those higher up the shore are entirely covered by a community of mussels very like that found on the Island Reef and at North Point. Here *Mytilus crenatus* is by far the most abundant species, though interspersed with a few *Mytilus meridionalis*.* To landward of the mussels enormous expanses of *Gunnarea capensis* cover the tops of most of the rocks. Indeed, from a distance the flats appear to consist almost exclusively of sheets and mounds of these sandy worm-tubes (similar masses from another locality are illustrated in Pl. IX).

The upper Balanoid zone is inextensive on the flats, as the rocks are low, but is present on the upper parts of those fairly near to the beach. It has much the same population as at Port Nolloth, except that sheets of *Balanus algicola* occur fringing pools and along the sides of rocks near the sandy beach.

The Littorina zone is represented where higher rocks are present, and on some parts of the cliff face.

The Rocks at Buchuberg.

The part of the shore examined was that lying below the more northerly of the two Buchuberg hills, a couple of miles (3 km.) south of Peacock's Bay. Only one day was spent there, as the locality is not easily accessible. Since the tides were at their minimum, detailed observations could not be made, but such as were possible indicate that the fauna, flora, and zonation greatly resemble those of the other areas studied at Port Nolloth and Cliff Point.

Discussion.†

A description of the shore at Oudekraal has been published in Part II of this series (the present issue of this Journal, pp. 49–65); but a discussion of the results was postponed until Port Nolloth had also been described, since the two places are best considered together.

1. *Zonation.* At both localities the zone immediately above the sub-

* On the steeper parts of the coast and in certain parts of the flats *M. meridionalis* greatly outnumbers *M. crenatus.*

† It should be noted that this discussion was sent to press before the appearance of the first part of W. E. Isaac's "Studies of South African Seaweed Vegetation," in 1937.

littoral fringe is typically inhabited, in the more wave-washed parts, by limpets in close-set formation. At Oudekraal this position is occupied by a *Patella cochlear* community such as has already been described for Still Bay (this Journal, vol. xxiv, p. 353), but with the difference that at Oudekraal the individuals of *P. cochlear* tend to be even more numerous per unit area than at Still Bay (as exemplified by a count of 1315 specimens on a typical square yard at Oudekraal, 256 on a comparable square yard at Still Bay). How general this difference may be it is as yet impossible to say; but the crowded condition found at Oudekraal has also been noted at several other places on the west coast.

At Port Nolloth a striking difference is apparent. Although several places in the area were studied, some of them on the open ocean and others partly sheltered, not a single specimen of *P. cochlear* could be found during the survey. Considering the amazing abundance of this species along so much of the South African coast, its apparent absence (for if it is present it must be rare) at Port Nolloth is remarkable, especially as we have confirmed its presence in abundance north of the Peninsula at Blaauwberg, Melkbosch, and Lamberts Bay. At Port Nolloth the region which would elsewhere be populated by *P. cochlear* is partly inhabited instead by a population of *P. argenvillei*. In the absence of precise instrumental determinations of levels at Port Nolloth and Oudekraal, it is difficult to compare the vertical extent of the Argenvillei zone at the one place with that of the Cochlear zone at the other; but, so far as could be determined, the zone of *P. argenvillei* has its upper limit somewhat below that of *P. cochlear*. The Argenvillei zone is seldom sufficiently exposed for drying to occur, whereas the upper part of the zone of *P. cochlear* is sometimes left dry for considerable periods. It may also be noted that in localities where *P. cochlear* and *P. argenvillei* coexist, the upper limit of the bulk of the population is at a lower level for the latter than for the former. Conversely, where *P. cochlear* is absent, the *argenvillei* community is more extensive and appears to persist to a higher level than where the two species occur together.

Above the Cochlear or Argenvillei zone, a Balanoid zone is distinguishable at both places. At Oudekraal the incrustation of barnacles in the lower part of this zone is often dense, consisting principally of two (*Octomeris angulosa* and *Tetraclita serrata*) of the three species prevalent at Still Bay and at many other places on the south coast. At Port Nolloth, on the other hand, these two species are relatively scarce, and the barnacle population of the zone in general is weakly developed, though *Chthamalus dentatus* is often characteristic not only of the lower part of this zone, but also of the region immediately below it.

A Littorina zone is recognisable above the Balanoid, at both places,

as at Still Bay; inhabited notably by vast numbers of *Littorina knysnaënsis* and by *Porphyra capensis.* The latter occurs in thick sheets on many of the rocks at Port Nolloth and Oudekraal, in occasional tufts only at Still Bay.

2. *The Algal Flora.* One of the outstanding differences between Still Bay on the one hand and Port Nolloth and Oudekraal on the other is the absence of a Laminarian zone at the former place, and its strong development at the two latter. The Laminarian community of the west coast at a given spot may include one or all of three giant species—*Ecklonia buccinalis, Laminaria pallida,* and *Macrocystis pyrifera.* The last mentioned appears to be confined in the main to the calmer water of more or less sheltered channels and lagoons. Of the other two, the *Ecklonia* is the predominating species at Oudekraal, though the *Laminaria* is not uncommon; whereas at Port Nolloth the position is reversed.

Apart from the Laminarians, the profusion of the algal growth at both localities is noteworthy, and the lower reaches of the intertidal region are frequently carpeted with fairly large, often leafy species, mostly brown in colour (though many belong to the Rhodophyceae). Typical constituents of this growth are species of *Gigartina, Champia* and *Iridea.* This particular type of growth is not present at Still Bay, the algae of comparable levels there being on the whole both smaller and of different species.

It is too soon as yet to attempt to compile lists of species characteristic of the west and south coasts, but there are a few points which should be mentioned here. Along the south coast, as far as we know it, species of *Sargassum* are a common feature; *Caulerpa* is represented by one or more common species; the corallines are present in a variety of species and genera; and *Gelidium pristoides* and *Hypnea spicifera* are ecologically important forms. At Oudekraal and Port Nolloth no *Sargassum, Caulerpa, Gelidium pristoides* or *Hypnea spicifera* were found; and the corallines appear to be represented by a much more limited number of species. It cannot yet be stated that these features are generally characteristic of the west coast (along which *Hypnea spicifera,* for instance, occurs intermittently), but they are features of probable significance worthy of further investigation. (A dwarf *Gelidium* is abundant at Oudekraal, but this is apparently not *G. pristoides,* though it may be *G. reptans.*)

3. *The Fauna.* Here, again, it is not possible at the present stage to go beyond the indication of features of probable significance.

It has been mentioned in a former paper (this Journal, vol. xxiv, p. 360) that on some parts of the South African coast, *e.g.* at St. James in False Bay, a dense community of ascidians (*Pyura stolonifera*) is abundant in the sublittoral fringe. At the west coast localities described these ascidians are plentiful, though nowhere forming the fields so characteristic of St.

James; they occur as isolated clumps or solitary individuals, or form a narrow belt among the marginal plants of the Laminarian zone.

At both Still Bay and the two west coast localities beds of mussels are of frequent occurrence, occupying wave-washed situations in the lower part of the Balanoid zone and overlapping into the zone below. At Still Bay these beds consist of *Mytilus perna*; at the other places of *M. meridionalis* and *M. crenata*. Our surveys so far suggest that *M. perna* is characteristic of the south coast and the other species of the colder water; but there is a considerable amount of overlapping, which will be described in a later paper.

The relative abundance of several species of limpets at Port Nolloth and Oudekraal is undoubtedly significant. At both places *Patella granatina*, *P. argenvillei* and *P. compressa* (species reaching their best development in the colder water) are abundant. *P. oculus*, a species of warm-temperate distribution, is moderately common at Oudekraal, but absent, so far as we could determine, from Port Nolloth. *P. longicosta*, another warm-temperate species, seems to disappear rapidly on the west coast. It was not found at Port Nolloth; and in the course of many visits to Oudekraal, extending over several years, only a single specimen was found there. The absence of *P. cochlear* from Port Nolloth has already been noted. Lastly, it may be observed that at both places *P. granularis* and *P. barbara* frequently attain large size, and this again is a feature of their occurrence in the colder water.

Lastly, it may be noted that the fauna of Oudekraal is interesting in itself, apart from other considerations, because of the profusion of coelenterates represented in it, both by species and individuals. This coelenterate fauna includes at least nine species of hydroids; an interesting creeping medusa (*Eleutheria vallentini*); a new lucernarian (*Depastromorpha africana*); nine species of anemones; two corals (*Corynactis annulata* and *Balanophyllia bonae spei*); several alcyonaria (*Alcyonium fallax*, *Wrightella coccinea*, *Eunicella papillosa*, and a species of *Clavularia*); a zoanthid (*Isozoanthus capensis*); and probably others as yet undiscovered. Presumably the presence of this rich array of coelenterates is partly connected with the very favourable habitat provided by the sublittoral pools and clefts, often deep and shaded, of the shore.

Summary.

A description is given of several rocky areas in the intertidal region in the district of Port Nolloth, a locality situated near the northern boundary of the west coast of the Union, and affected by cold inshore water. The intertidal belt here is subdivided for descriptive purposes into four zones,

from above downwards the Littorina, Balanoid and Argenvillei zones, and the sublittoral fringe. The Argenvillei zone approximately replaces the Cochlear zone described in Parts I and II of this series as characteristic of Still Bay and Oudekraal. The algal flora at Port Nolloth is characterised by the presence of a strongly developed Laminarian belt, dominated by *Laminaria pallida*; and by a profuse growth of other algae, many of them of considerable size. The fauna and flora undoubtedly include species which disappear sooner or later along the south coast, and lack other forms characteristic of that coast; but as yet only a preliminary indication of the identity of these species can be given.

APPENDIX.

Notes on the Population of the Pools and Channels.

1. *The fauna of the channels at Hotel Rocks.* It has already been remarked that the channels fall into two groups. Those belonging to the lower group are sublittoral (*i.e.* in communication with the sea at low water), while the others, though wave-swept at high water, remain dry, except for isolated pools, during a large part of the tidal period. The animals inhabiting these channels may be subdivided into forms which prefer the upper surfaces of rocks and stones, and forms confined to their undersurfaces. The species which fall into the former category correspond in general with those of the adjacent ridges, though in many cases animals extend to higher levels in the channels and pools than on open rock. The cryptofauna of the channels is abundant and constant though not very rich in species. A description of a typical sublittoral channel is given in the following paragraph.

This channel (fig. 2, A) varies much in width and depth. It is narrow and from 1 to 3 feet (0·3–0·9 m.) in depth at the one end, gradually widening out and becoming shallower towards the other, when it merges with the neighbouring channels. Its floor is composed of rocks and stones, between which are packed smaller pebbles embedded in sand. Most of this substratum is encrusted with pink and mauve lithothamnion on which live numbers of limpets (*Patella granularis*, *P. granatina*, *P. barbara*, and occasional specimens of *P. miniata* or of *Helcion dunkeri*), whelks (*Cominella delalandii*) and various small snails such as *Oxystele zonata* and *Tricolia kraussi*. Vivid anemones are numerous. Many of the stones are cemented together by sandy tubes of *Gunnarea capensis* or by *Hymeniacidon sanguinea*. Cirratulid worms are commonly found living in the fine muddy sand between the stones. Of these the orange variety of *Audouinia filigera* is the more abundant, though a blackish form with creamy pink cirri is also present.

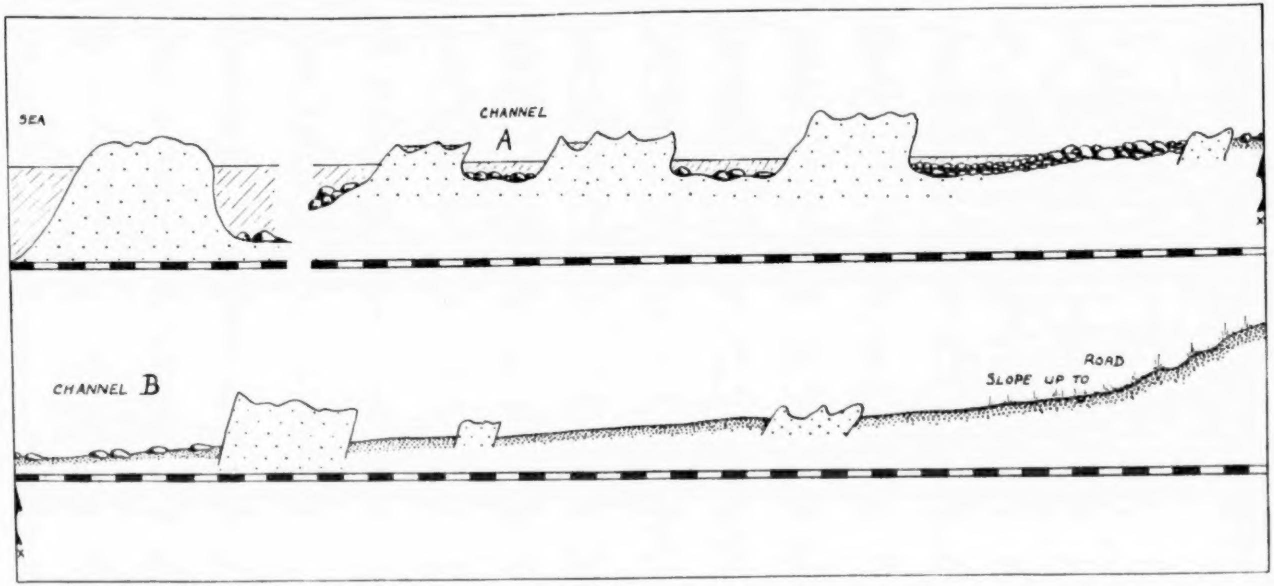

Fig. 2.—An approximate cross-section of the ridges and channels at Hotel Rocks, Port Nolloth. Based on measurements made with a surveyor's tape. Water is indicated by lines of shading; sand by dots; and rock by more widely spaced dots. Below the section the scale is indicated in yards.

The whelks and periwinkles already mentioned are found beneath the stones, and one small gastropod, *Marginella biannulata*, is confined to that habitat. Other members of the cryptofauna are chitons (*Ischnochiton elizabethensis*); anemones; encrusting sponges, ascidians (*Didemnum lutarium*) and polyzoa (none of which are very plentiful); various polychaets (*Euphrosyne capensis*, *Spirorbis borealis* and polynoids); brittle-stars (*Amphiura capensis*); occasional *Asterina exigua* and *Mytilus crenatus*; and countless minute crustaceans of various species (*Ceradocus rubromaculatus*, *Paramoera capensis*, etc.).

The higher channels, which are only covered by the sea at high water, have a much poorer fauna than the sublittoral channels, and this fauna becomes progressively scantier towards the top of the shore. A typical pool in one of these channels (fig. 2, B) is described in the next paragraph.

Towards the southern end the bed of this channel consists at low water of dry sand and shingle, but farther along it becomes rocky. The pool described lies in the rocky part; it is fairly large and shallow and floored with stones and sand. The animals living on the stones are the limpets *Patella granularis*, *P. granatina* and *Helcion dunkeri*, a few *Siphonaria capensis* and *Asterina exigua*, and numbers of *Oxystele variegata* and *Cominella delalandii*. The cryptofauna includes the ubiquitous *Ischnochiton elizabethensis*, young specimens of *Oxystele*, and myriads of small crustaceans, the commonest of which are probably certain isopods (*Exosphaeroma laeviusculum* and *Parisocladus perforatus*), while an amphipod, *Paramoera capensis*, is also very plentiful.

2. *Pools in the ridges at Hotel Rocks.* There is, in addition to the channel pools, a fairly large number of small deep water-filled cracks and crevices in the ridges. As in the case of the channels, the fauna of these may to a large extent be correlated with that of the adjacent rock-surfaces. As an example, a crevice-pool in the upper Balanoid zone will be described. This pool is a narrow deep crack lined with greyish lithothamnion, which also fringes it. The animals are almost entirely obscured by a thick growth of algae (*Chordaria capensis* and *Bryopsis setacea*). Round the water's edge are specimens of *Bunodactis reynaudi*, and numbers of *Siphonaria capensis* and *Diodora mutabilis*. In the deeper parts, half-hidden by the algae, there are in addition *Cominella delalandii*, a few *Mytilus crenatus* and a small greenish-brown anemone (*Anthothoë*). Small crustaceans are as usual plentiful, particularly among the algae, where *Paridotea ungulata*, *Hyale saldanha*, and *Paramoera capensis* are all to be found.

3. *Rock-pools on the Island.* Towards the shoreward side of the island, where the rocky outcrops are very low, they are covered with loose stones and contain many large shallow pools. These pools contain a very rich fauna, which is denser and more varied than that found anywhere else

near Port Nolloth. Most of these very shallow pools have a substratum of large flat stones resting on fine muddy sand. The upper surfaces of the stones are coated with lithothamnia and short corallines, and also support a few plants of such algae as *Iridaea capensis* and *Leathesia difformis*. Various animals also occupy this habitat. These are principally molluscs (*Patella granatina*, *Diodora mutabilis*, *Thais squamosa*, *T. cingulata*, *Rissoa nigra* and *Mytilus crenatus*) and coelenterates (*Corynactis annulata* and anemones). A soft orange sponge (*Hymeniacidon sanguinea*) grows in crevices between the stones.

The cryptofauna is extremely rich and very constant throughout these pools. Most conspicuous are thin sheets of soft sponges, particularly a cream-coloured form (*Hymeniacidon styliferus*), and various compound ascidians of which a bright orange species is the most frequent. In addition to these encrusting forms many of the stones, and the huge *Mytilus crenatus* which live beneath them, are covered with fields of pink and red *Corynactis*. Other characteristic animals are anemones, and molluscs such as *Ischnochiton elizabethensis*, *Cominella delalandii*, *Marginella biannulata* and *Diodora mutabilis*. Most striking, however, is the great abundance of echinoderms and worms. Common echinoderms include the small pinkish urchin *Parechinus angulosus*, an ophiuroid (*Amphiura capensis*) and a vivid red sea-cucumber (*Cucumaria insolens*). Another holothurian, *Thyone serrata*, is sometimes seen. Asteroids are less frequent, but occasional specimens of *Echinaster ornatus* and *Asterina exigua* are encountered. Polychaets include *Euphrosyne capensis*, *Terebella pterochaeta*, the two varieties of *Audouinia filigera*, and the polynoids *Lepidonotus semitectus* and *Polynoe erythrotaenia*. Large sipunculids live buried in the sand beneath the stones. Of crustaceans, isopods such as *Sphaeramene polytylotos* are common, and other species such as *Paridotea rubra*, *P. fucicola* and *Glyptidotea lichtensteinii* are also to be found.

4. *Rock-pools at North Point.* Four main types of pool fauna are found at North Point.

The large shallow pools in the region of the mussel community are packed with animals of various kinds. *Mytilus meridionalis* and *Bunodactis reynaudi* form sheets covering the floors of the pools, while *Parechinus angulosus* and an assortment of molluscs (*Diodora mutabilis*, *Argobuccinum argus*, *Cominella delalandii*, *Crepidula hepatica* and *Mytilus crenatus*) are all present in large numbers. The algal growth is poor, apart from corallines and lithothamnia.

Pools towards the middle of the Balanoid zone are lined with encrusting algae (*Lepadoderma africanum* and *Hildenbrandtia pachythallos*) and contain such molluscs as *Patella granatina* and *Tricolia kraussi*, sponges (*Hymeniacidon sanguinea*) and small plants of *Splachnidium rugosum*.

Most of the pools in the higher parts of the Balanoid zone are of considerable size and are filled with algae (*Ulva Lactuca*, *Chordaria capensis* and *Cladophora flagelliformis*) in which the animal inhabitants (chiefly *Oxystele variegata*) are almost hidden.

Pools in the Littorina zone are mainly populated by *Siphonaria capensis* and *Littorina knysnaënsis*, and contain a good growth of *Enteromorpha*.

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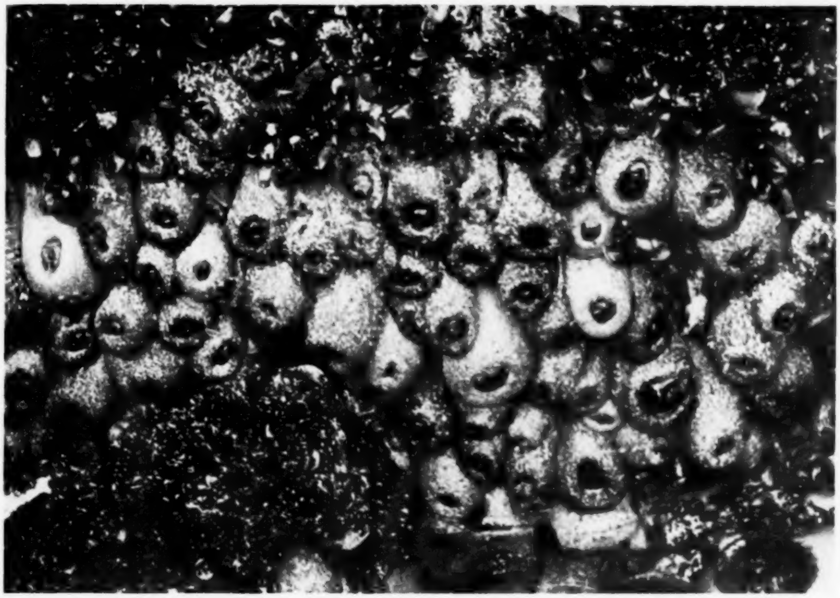
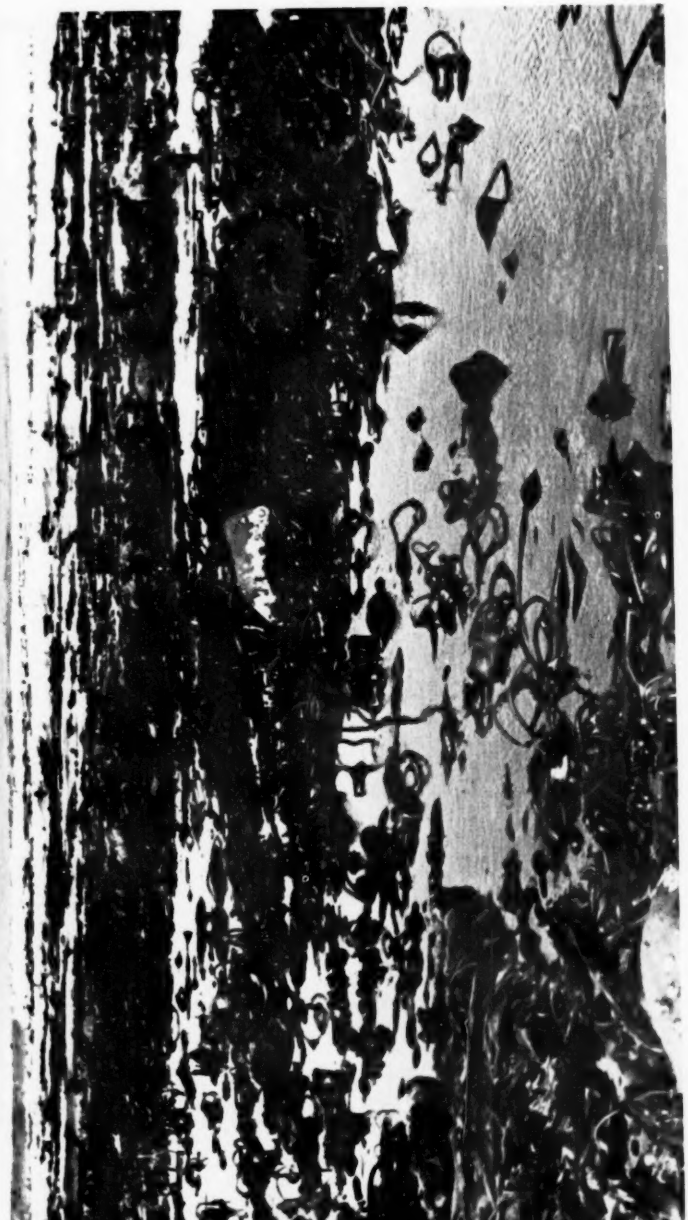


FIG. 1.—The large many-coloured anemone *Bunodactis reynaudi*, in typical dense formation, associated with *Mytilus meridionalis*, at Hout Bay (Cape Peninsula). From a photograph by G. J. Broekhuysen.

FIG. 2.—The zone of *Patella argenvillei* near Schusters Bay (Cape Peninsula); with tubes of *Gunnarea capensis* in foreground and background. From a photograph by G. J. Broekhuysen.



The Laminarian zone near Slangkop Lighthouse (Cape Peninsula). From a photograph by G. J. Broekhuysen.

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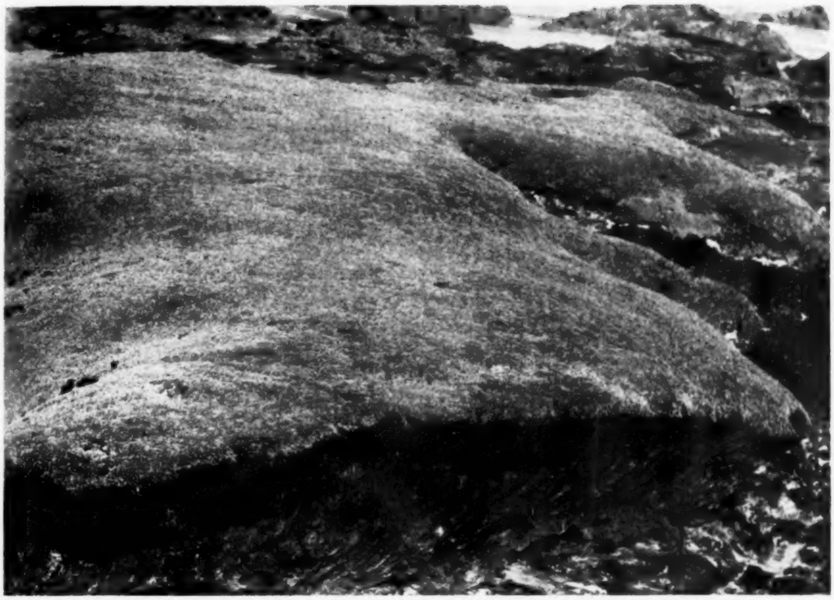

FIG. 1.—A mass of tubes of *Gunnarea capensis*, at Witsands (Cape Peninsula). Such masses cover large areas of the rocks at certain localities, and attain a thickness of fifteen inches or more. From a photograph by R. T. Scott.

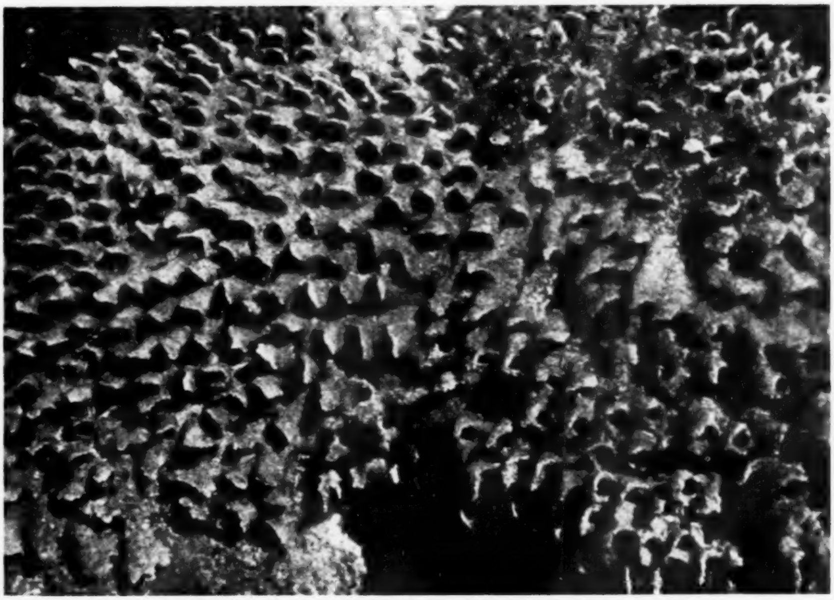

FIG. 2.—A small group of *Gunnarea* tubes, seen at close quarters. From a photograph by T. A. Stephenson.

A NOTE ON THE DISTRIBUTION OF CHEMICAL COMPOUNDS IN THE INNER AND OUTER PORTIONS OF THE FLESH OF THE KELSEY PLUM.

By I. DONEN.

(Read October 20, 1937.)

In a previous study of the relationship between internal browning and nitrogen metabolism of stored Kelsey plums, results were presented showing that the portions of the flesh around the stone have a higher nitrogen content than the outer layers. It was also observed that internal browning of the plum due to cold storage injury usually occurred first in the region near the stone, and that with progressive spread of the browning outwards the nitrogen gradient appeared to alter, the nitrogenous compounds seemingly concentrating in the layers of "active" browning (2).

The above observations were made late in the season when no fresh fruit was available to determine whether differences in nitrogen concentrations in the flesh existed during growth too. It is generally accepted that sugars are in greater concentration in the outer portions of the fruit, but no information is available as to the distribution of nitrogenous compounds.

During the 1936–37 season a number of analyses were therefore made of samples of fruit of varying age. The results are given in Table I. The methods of sampling and analysis have been described in detail elsewhere, and only brief reference to them is needed here (1). After selecting a sample of fruit by a method of random sampling, the plums were quartered and divided into two sub-samples consisting of alternate quarters. One sub-sample was finely cut up, and mixed; analysis of a portion of this gave the results for the "whole sample." The second sub-sample was further subdivided into two portions: the inner portion containing the layers of flesh around the stone, and the outer portion containing the epidermis and immediately adjoining layers. These two samples were then analysed separately. The proportion by weight taken for each of the inner and outer portions are shown in Table I.

The analysis consisted of estimations of dry weight, total nitrogen, total alcohol-soluble nitrogen, and fractions of the latter, namely, amino-nitrogen, amide nitrogen, and ammonia nitrogen. Furthermore, total sugars and titratable acid were also estimated.

Table I.

Comparison of Concentration of Nutrients in the Inner and Outer Portions of the Kelsey Plum during Growth.

All results on the basis of Fresh Weight. Acid as per cent. Malic Acid.

Sample.	I. Inner.	I. Outer.	I. Whole S.	II. Inner.	II. Outer.	II. Whole S.	III. Inner.	III. Outer.	III. Whole S.	IV. Inner.	IV. Outer.	IV. Whole S.	V. Inner.	V. Outer.	V. Whole S.
Days from petal fall		100			132			141			149			157	
Wt. per fruit, gm.		86·2			129·0			132·0			134·0			134·0	
Ratio of wt. of inner/outer		33·0 / 67·0			50·7 / 49·3			46·2 / 53·8			47·3 / 52·7			49·3 / 50·7	
Dry wt. %	13·63	13·28	13·27	15·70	15·32	15·08	16·11	15·92	16·62	17·10	17·13	17·10	19·74	19·85	19·90
Sugars %	6·79	7·25	6·96	9·64	10·23	9·93	10·17	10·52	10·37	11·18	14·94	13·17	12·24	13·25	12·75
Acid %	·129	·142	·138	·0795	·106	·102	·104	·126	·118	·0980	·115	·107	·0855	·109	·0970
Total N, mgm.	164·2	94·6	117·6	126·0	88·2	107·3	138·9	90·6	113·0	132·7	88·1	109·1	121·2	99·2	110·0
Protein N, mgm.	38·2	41·3	40·3	37·8	42·1	39·9	33·8	45·3	40·1	40·3	39·8	40·0	29·0	50·3	39·3
Soluble N, mgm.	126·0	53·3	77·3	88·2	46·1	67·4	105·1	45·3	72·9	92·4	48·3	69·1	93·2	48·9	70·7
Amino N, mgm.	43·0	22·4	29·2	33·5	18·6	26·3	41·3	18·6	29·0	39·6	18·6	28·2	38·8	19·8	29·1
Amide N, mgm.	46·6	17·6	27·2	31·9	14·2	23·3	37·1	10·7	22·9	28·1	15·0	21·2	28·1	12·2	20·2
Ammonia N, mgm.	4·83	2·21	3·07	2·74	1·85	2·30	3·02	1·68	2·31	3·19	2·05	2·65	3·64	3·31	3·48
Protein N (% total N.)	23·1	43·7	34·2	30·0	47·7	36·6	24·4	50·0	35·5	30·4	45·2	36·0	23·0	51·6	35·7
Amino N (% total N.)	26·2	23·6	24·8	26·6	21·1	24·7	29·8	20·5	25·8	29·8	21·1	25·8	32·0	20·1	26·5
Amide N (% total N.)	28·4	18·6	23·1	25·3	16·1	22·1	26·7	11·8	20·5	21·4	17·0	19·5	23·2	12·3	18·4
Ammonia N (% total N.)	2·94	2·33	2·61	2·17	2·10	2·0	2·17	1·85	2·1	2·40	2·33	2·43	3·01	3·34	3·17
Amino N (% sol. N.)	34·1	42·0	37·7	38·0	40·3	39·0	39·4	41·0	39·8	42·8	38·4	40·8	41·7	40·4	41·2
Amide N (% sol. N.)	37·0	33·0	35·2	36·2	30·8	34·6	35·3	23·6	31·4	30·4	31·0	30·7	30·2	24·9	28·6
Ammonia N (% sol. N.)	3·84	4·15	3·97	3·11	4·02	3·41	2·88	2·70	3·17	3·45	4·23	3·83	3·90	6·75	4·93

The "dry weight" values of the inner and outer portions were in no instance significantly different. The results shown in Table I as percentage of fresh weight may therefore also be taken to represent the various estimates on the dry weight basis.

The results for sugar and acid show that they are in somewhat higher concentrations in the outer than in the inner region. This is to be expected, for the carbohydrate supply of the fruit may come from two sources: by translocation from the tree and by original synthesis in the chlorophyll rich layers. The slight downward gradient of sugar from the outer to the inner regions is then explainable if the rate of translocation of sugar compounds from the tree is less than the rate of sugar synthesis in the outer regions of the fruit. Since acids are most probably by-products of carbohydrate metabolism, the higher concentration of acids in regions of higher sugar concentrations is also to be expected.

The distribution of nitrogenous compounds is completely different from that of sugar and acids. Total nitrogen is always higher in the inner than in the outer portions. The higher concentration of nitrogen in the region around the stone appears to be due almost entirely to the soluble nitrogen fraction. A consideration of the soluble and protein nitrogen values shows that there is usually twice as much soluble nitrogen in the inner portion as in the outer. No similar relationship holds for the protein fraction, which is slightly higher (and in two cases considerably higher) in the outer than in the inner portions.

The nitrogen supply of the plum could come from one source only, by translocation from the tree through the stalk. Therefore it is possible that the high accumulation of soluble nitrogen in the inner layers might be due to the rate of translocation into the fruit being greater than the subsequent rate of migration of nitrogen through the various layers in the fruit towards the epidermis.

When expressed as percentage of total nitrogen the results show that the proportion of nitrogen utilised for protein synthesis is almost twice as great in the outer as it is in the inner layers. Thus it would appear that not only sugars, but also proteins are more actively synthesised in the outer than in the inner portions of the fruit.

The composition of the soluble nitrogen fractions of the inner and outer portions of the plum varies slightly. In the outer portion ammonia nitrogen is somewhat higher, and the difference between amino and amide nitrogen is greater, than in the inner layers.

The results reported in this paper have an important bearing on the sampling procedure usually adopted when plums and possibly other fruits are being prepared for analysis. Careful mixing of all portions of the fruit is essential if representative results are to be obtained.

Summary.

1. A comparison was made of the chemical composition of the inner and outer layers of the Kelsey plum during growth.

2. Sugars and acids were found to be in somewhat higher concentration in the outer than in the inner layers.

3. Total nitrogen was found to be always higher in the inner than in the outer regions. The high nitrogen concentration in the inner portion was due entirely to the soluble nitrogen fraction. Protein nitrogen was distributed fairly evenly throughout the body of the fruit.

4. The percentage of total nitrogen utilised for protein synthesis was found to be almost twice as great in the outer as in the inner layers.

5. The results obtained emphasise the importance of careful mixing of the sample in preparation for analysis.

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1. Donen, I., "Studies in Deciduous Fruit: V. Preliminary Observations on the Relationship between Nitrogenous Metabolism and Internal Breakdown of Kelsey Plums in Cold Store," Trans. Roy. Soc. S. Afr., vol. xxv, 1927.
2. Donen, I., "The Nitrogen Metabolism of the Kelsey Plum during Growth." (In publication.)

SOUTH AFRICAN NATIVE CERAMICS: THEIR CHARACTERISTICS AND CLASSIFICATION.

By P. W. Laidler, F.S.A.Scot., F.R.A.I.

(With Plates X–XVII, and seventeen Text-figures.)

(Read March 18, 1936. Revised M.S. received August 8, 1936.)

CONTENTS.

TABLE OF REFERENCES TO COLLECTIONS.

H. . . .	Author's collection, Hunterian Museum, Glasgow.
P.W.L. . .	Author's collection. In course of transference to Witwatersrand University Museum.
A. . . .	Albany Museum, Grahamstown, C.P.
B. . . .	Bulawayo Museum, S. Rhodesia.
S. . . .	Salisbury Museum, S. Rhodesia.
K. . . .	Kimberley Museum, C.P.
S.A.M. . .	South African Museum, Cape Town.
W.W.R.M.S. .	Witwatersrand Medical School Museum.
W.W.R. . .	Witwatersrand University Ethnological and Archaeological Museum.
P.E. . .	Port Elizabeth Museum.
D. . . .	Durban Museum.
E.L. . .	East London Museum.

Section I. Introduction.

The evidence on which this account of South African native ceramics, ancient and modern, is based was obtained during two excursions to Namaqualand, 1911–12, a residence there during 1921–24; visits to the museums listed; numerous short-period investigations and excavations of two to fourteen days of shell mounds, caves, open sites, from Natal to Port Elizabeth; and archaeological tours of Bechuanaland, Southern Rhodesia, and the Union between the years 1929–35. Most of the sites mentioned in the text have been visited by the writer. Excavations on varying scale were conducted on a considerable number of stone-building culture sites which it is hoped to describe in a separate publication. Other sites have been collected and extensive collections have been housed in the Hunterian Museum, Glasgow, the Witwatersrand University Museum, and the Albany Museum. Where important objects are mentioned, the whereabouts of these is indicated.

Section II. The Art of the Potter.

Clay, the material in which the potter works, is a heterogeneous mixture of certain hydrated aluminium silicates, with particles of quartz, felspar, and other substances. Plastic clay is shaped by man; firing hardens and fixes more or less permanently its form, and so preserves for the archaeologist a good index to the general cultural level of the potters. The correct firing temperature for any given clay depends upon its chemical composition, and accounts in part for the endless variety of body textures found among South African potsherds. The presence of such substances as iron pyrites is detrimental to potting. The amount of iron present and the temperature utilised, a very variable matter in the native potting industry, affects the colour of the finished product. Low percentages of iron produce buff colours; medium, salmon; over 4 per cent., red; and over that, darker tones. Lack of oxygen during firing produces black colours; presence of oxygen, the red iron oxide colours. An intermediate stage produces beautiful mottling, which varies with the position of the pot, the amount of fuel, and its type, whether wood or dung.

Potting implies industry, and forms an outlet for the artistic urge. Pottery is a good, though rough, index of civilisation, and, being fragile, is rarely carried far from the place of its manufacture except among more highly civilised people than existed among the pre-European natives of South Africa.

Section III. Potting Technique of Known African (North and South) Native Origin, Modern.

The clay is usually specially chosen, with the result that the body is homogeneous in texture among Ovambo (1), Kghatla (2), Baronga (3), Pondo (4), and Hottentots (5).

It is dried, powdered, and then sifted or gravitated in winnowing baskets to remove impurities by the Baghatla at Mochudi (Miss Wilman). Balemba women seem to possess a peculiar knack of choosing and mixing clay, and a skilful touch in moulding it (Mr. Dicke).

The carefully chosen clay is kneaded and pounded with a special stone by the Ila of N. Rhodesia (6), and is pounded with a log on a stone at Katanga (7), and by the Nama Hottentots (5).

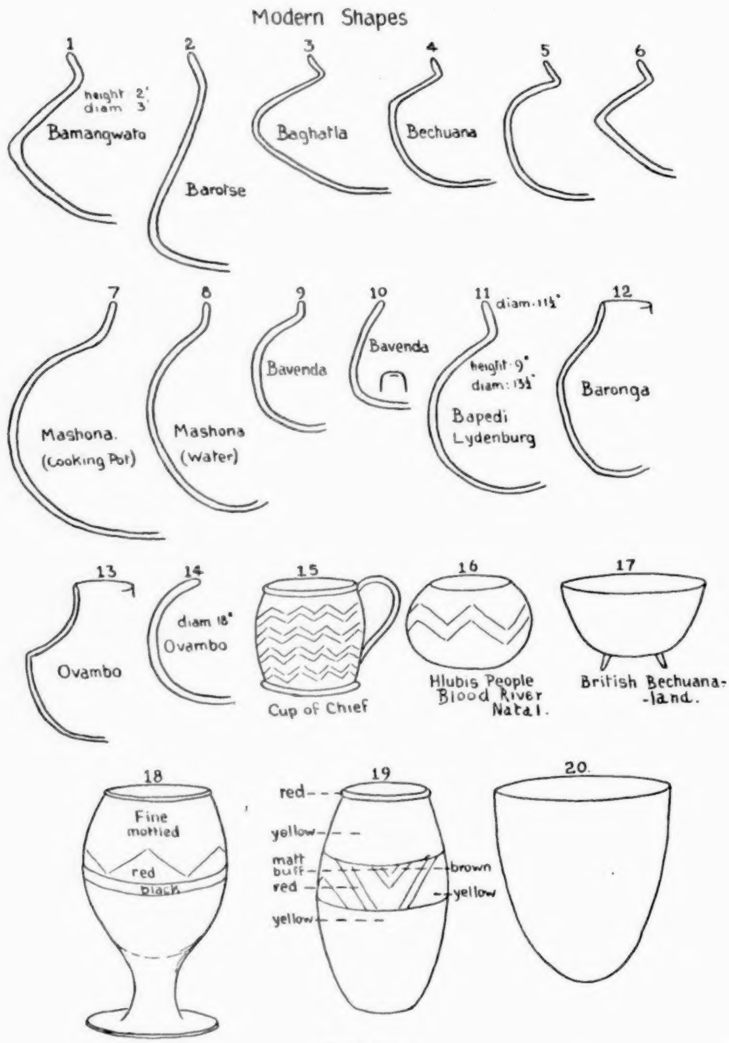
Certain materials (the admix) are added to the clay in order to temper it, to produce a porosity in order that moisture may escape before firing. Some, the Ila of N. Rhodesia (6) and the Baronga (3), add ground potsherds; others add sand, among them the Baronga and the Southern Bantu (8). The Bahurutsi of the South-Eastern Transvaal add powdered asbestos; pounded quartz is added by modern Bechuana and is common in Hottentot pottery of the Eastern Province, but does not there appear in other types. A lack of admix or much natural admix is common in the Bushman and Hottentot wares and the degenerate Bantu pottery of many areas. Grass was used by South African Bushmen (9), not to produce porosity, but to help bind a badly prepared clay.

The moulding of the clay takes place on a stone or an ant-heap floor among the Ila and the Mashona, who also build the pot from the neck upwards, and form the base by gradually drawing in the added rings of clay (Ila, Baghatla, and Pondo), the thickness of which varies considerably. The base is added as an internal plate to the first ring by the Pondo (4).

Pots are more crudely raised direct from the lump, over the hand, by the Baronga. The Bamangwato or Bechuana make large pots raised from the lump over the hand, 2 feet high and 3 in diameter, for beer-making. These usually have a powdered quartz admix. This method, without the use of quartz, is the sole technique practised by Bushmen.

The treatment of neck and body varies considerably, the neck is added as a separate portion by the Ila of N. Rhodesia, who indent the pot base in order that it may stand.

The surface of the moulded clay is burnished with water and a stone—with wood by the Ila, who also use mealie cobs or bone; and the use of potsherds and leather is also recorded. Shells are kept specially for the purpose by the Mashona (10). The Bahurutsi use a special stone (*teedaelo*) and so do the Basuto.


Modern Shapes
1
height 2'
diam 3'
Bamangwato
2
Barotse
3
Baghatla
4
Bechuana
5
6
7
Mashona.
(Cooking Pot)
8
Mashona
(Water)
9
Bavenda
10
Bavenda
11
diam. 11½"
height 9"
diam: 13½"
Bapedi
Lydenburg
12
Baronga
13
Ovambo
14
diam 18"
Ovambo
15
Cup of Chief
16
Hlubis People
Blood River
Natal.
17
British Bechuana-
-land.
18
Fine
mottled
red
black
19
red
yellow
matt
buff
red
yellow
brown
yellow
20.

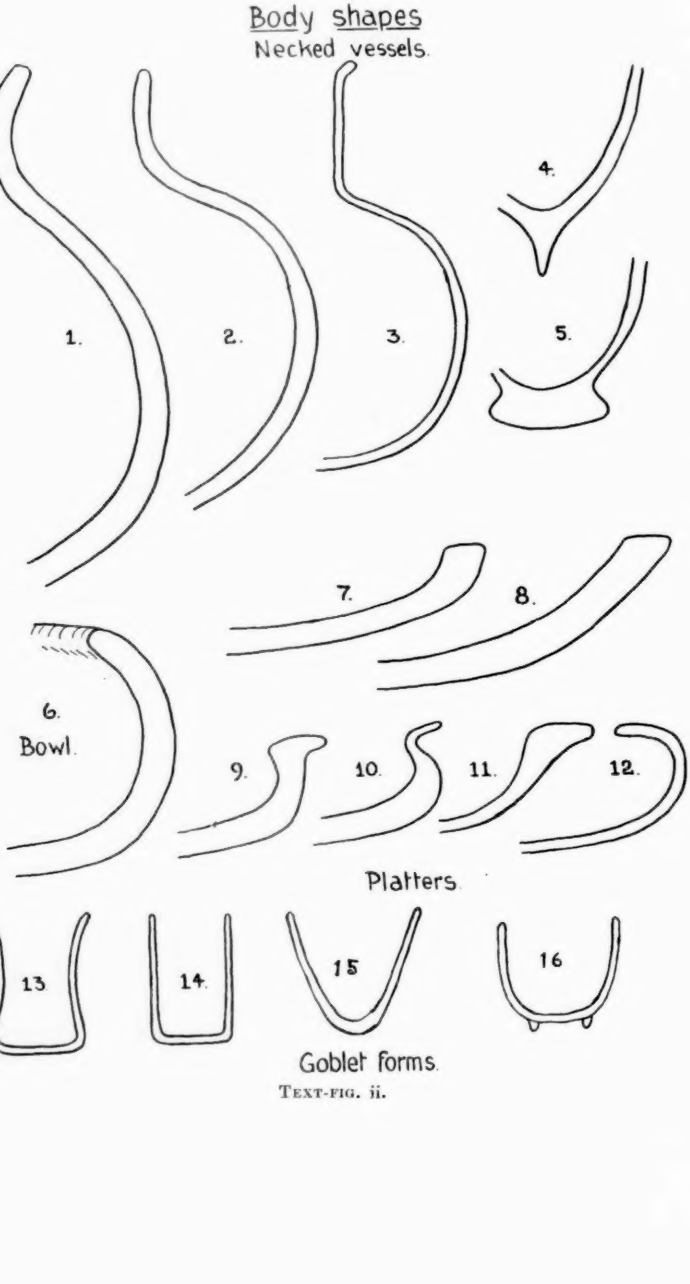
TEXT-FIG. i.

Most native potters sun-dry the moulded pot, but the details of the important process of firing vary. The Pondo places pots to be burned in a small depression in which a fire has been lit, and firewood is piled between them, alongside and on top. Firing takes from one and a half to two hours, and they stand in the ash to cool for twenty-four hours. The Pondo pot is made in large sizes and has notched ornamentation of lips. The Baghatla kiln is a hole in the sand and the fuel desiccated dung. The Basuto potter frequently fails in his work because of his use of dry dung as a firing material (11) in the open air of his now almost woodless country. Both Bechuana and Baghatla pots are at times, especially in the larger forms, thick and coarse, poorly burned, and the body striated with air bubbles. The rough body of the unburned pot has its hollows filled with scraps of clay before burnishing. The Bahurutsi fire their pots in a hole in the ground and use dry dung, and are now beginning to use dried mimosa bark as well (Chief Manyani of Mochudi, Transvaal), and burn during the whole night. Pots are placed either mouth up or down. The Baghatla places the raw pot upon a sherd in the kiln (Miss Wilman). The Baronga fire their pots in a hole in the ground, with firewood over them. Occasionally Bantu firing is so fierce that the pot is almost vitrified. Bushman firing is so slight that the organic matter in the pot remains unoxidised, the black colour remains unaltered, and the body is friable. Irregular firing produces fine mottling, as in Makalanga pots.

The Masarwa Bushmen around Lake Ngami make ovoid-bodied, cone-based, long-necked pots, somewhat vase-shaped. Their technique is Bushman, the form of their pots Bantu.

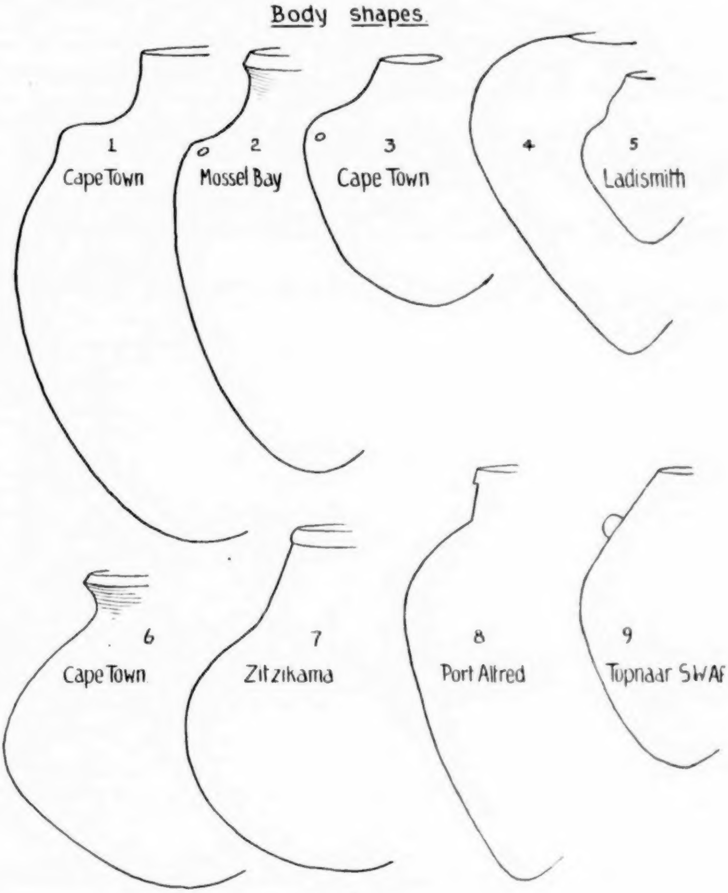
Potting is the work of women among the Baronga, Malemba, Ovambo, the Southern Bantu, Basuto, Bahurutsi, Bushmen, and the Nama Hottentots. The Baghatla potter at Mochudi in the Bechuanaland Protectorate is a professional, and the art is not universally known to the womenfolk. Certain Mashona villages (10) have a monopoly of pot-making.

Among the Ovamba (1) the most suitable clay is found in the Ukuambi district, which is noted for its potters and supplies the bulk of the country's requirements. Workmanship does not show the great skill met with among certain of the Union tribes. The large beer or water vessels and meat dishes are nevertheless remarkably symmetrical in form. The globular pot is used for cooking, stood between three stones. The common forms of pots are globular with sloping or vertical necks (text-fig. i, Nos. 4, 5, 7, 9, and text-fig. ii, Nos. 1–3), and there is a strong tendency towards flat platters and shallow bowls (*e.g.* text-fig. ii, 12). At Shibudzi, in Portuguese East Africa, the Baronga find excellent clay, and the people in that district supply the whole country with pottery. The art is not hereditary among them.


Body shapes
Necked vessels.
1.
2.
3.
4.
5.
6.
Bowl.
7.
8.
9.
10.
11.
12.
Platters.
13.
14.
15
16
Goblet forms.

TEXT-FIG. ii.

Few taboos and magic in connection with potting are recorded. And here also there is an essential similarity between North and South. Among



TEXT-FIG. iii.

the Pondo, a "soft head" (*intloko etambileyo*) is forbidden to enter a hut where pots are drying, and for this reason strangers are kept out of such huts (4). When the Baronga woman goes to the marsh to gather clay no one greets her (3), everyone pretends not to see her, to prevent ill-luck coming to the venture. Imperfect pots are broken, and only perfect ones

ornamented. Only one woman digs clay and gives to another; should two dig some mishap would occur. Pots on completion are tested, washed with water, which is thrown away, some grains of maize are cooked and thrown away, so removing the danger of an untested or unpurified pot, otherwise the user would suffer from pimples. If pots are well made, she who dug the clay has a lucky hand: "let her dig another time." An innocent child is chosen to set light to the pot furnace or kiln, and once again, if pots are good, the child becomes fire lighter in chief. If bad, the bones are consulted. The sacred tree altar is a broken pot, into which offerings are poured.

Among the Bahurutsi at Mochudi, near Zeerust, the clay is dug in a private place by a special person. The digger may be accompanied by other women, but they must remain outside the clay pit, otherwise the pots, when made, would break. The clay is kept at a distance from the houses, and when potting is in progress none but workers are allowed near.

Woman makes woman's articles. Her sway is paramount in the kitchen, therefore it is she who must gather the clay and make cooking pots and the beer pots in which she will have to ferment the beer for her menfolk. Man makes his own pipes and weapons.

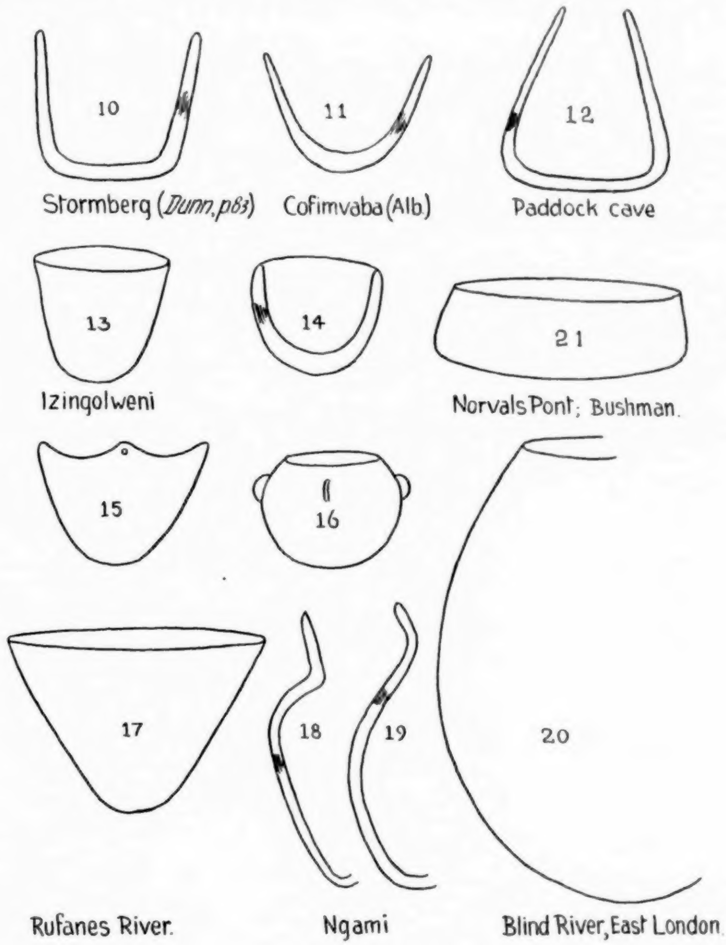
Bushwomen (17, p. 345) dug the clay, mixed it with grass, moulded it by hand, anointed it with fat so that the dampness dried out from inside. When air-dried, doornbosch gum was fused, water placed in and boiled, and the outside of the pot anointed by gum lifted out with a springbok horn spoon. If springbok were at hand, one was killed, blood brought home in its stomach and boiled in the new pot, and dried in. Then meat and water were cooked in it. Bones were not broken in the vicinity during the operation, to prevent cracking the pot.

The use of the wheel is unknown to Africans except along a strip of Nile bank (16). On the Blue Nile (15) pottery has certain peculiarities, shell and leather are used for burnishing the unfired pot. The base is raised from the lump, and the neck added by roll. Soot is used for colour burnishing. Vertical necks and appliqué meanders are suggestively like Bahurutsi pottery and that from Rhodesian and Orange Free State ruins.

In the various stages of potting technique there is no essential difference north or south of the Zambesi, and the forms even are comparable with those of the south.

Namaqua Hottentot potting was described to the writer (1921) by William Saul, then over seventy, whose mother was a potter. The pots were used for storage and cooking, and were of such hardness that they could be used for rendering fat. Her method was, on obtaining suitable clay, to beat with a stone about 6 inches long and oblong section (H), and work it thoroughly, then roll it into long cylinders, a large one coiled on

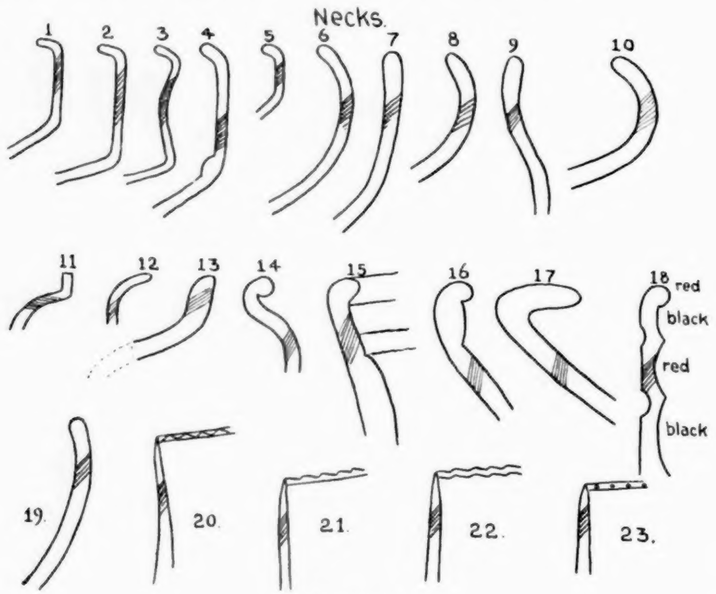
the flat formed the base, and ring superposed on ring, widening to the centre of the pot, then narrowing to the mouth. Each ring was



TEXT-FIG. iv.

carefully incorporated with its neighbours. The pot was sun-dried for two or three days, placed bodily in a fire of bush, and fire built up around it. Nama pottery died with that generation, *i.e.* about seventy years ago.

Bushmen of the Kalahari (12) made a little coarse, crude, and brittle pottery. It was pointed at the bottom (14), carried by thongs around the mouth, and was "smooth polished like pre-dynastic pottery of Egypt." The more primitive tribes of Ngamiland copied the tall jug in earthenware. To-day they carve jugs and bowls out of soft Marula wood.

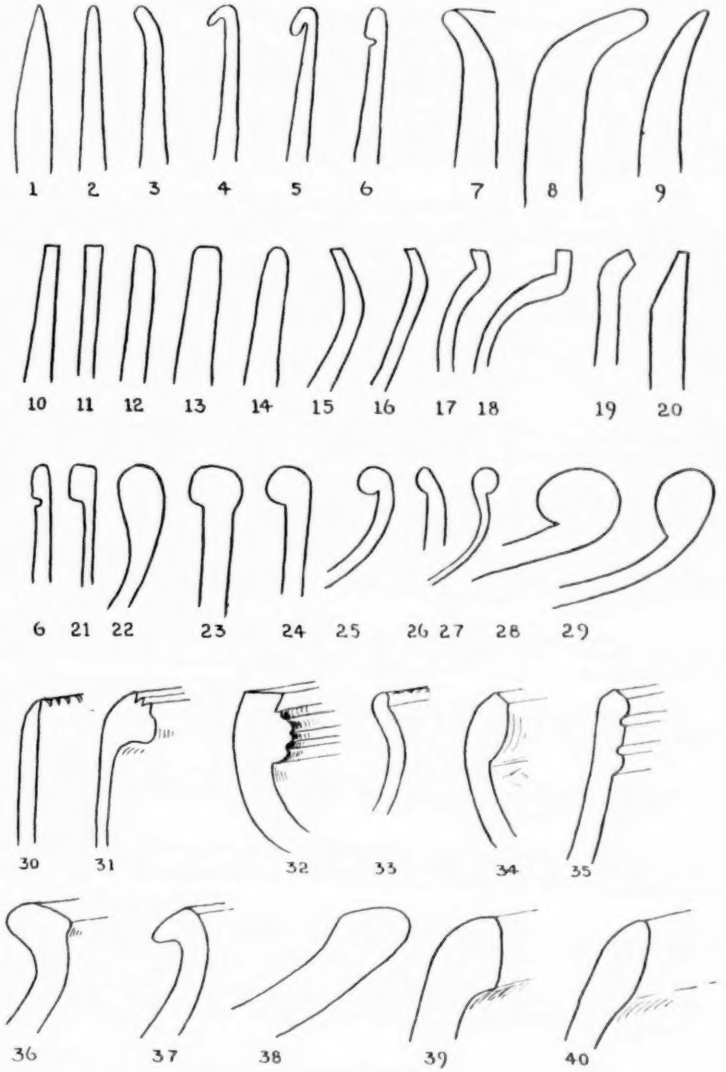


TEXT-FIG. V.

SECTION IV. BASES, NECKS, LIPS, LUGS, AND MAMILLAE.

The origin of any given ornamented sherds can be fairly confidently stated within the limits of barter and national conquest, after an inspection and consideration of certain characteristics.

Ribbon or roll technique shows in slight concentric circles when the base may show an ammonite spiral (Plate XIV, No. 1) or in sherds by overlapping sections. The neck-body technique is similarly identifiable, and may show a thickened consolidation area, a ridge, and trim mark, within or without. The body may be built upon the neck, with possibly an external reinforcement, as in Hottentot pottery, at the weak basal point of finger withdrawal. The neck may be added to the body as in Bantu pottery, when usually it is narrow. Lips show varying thickness, inversion, eversion, bevel, taper, overlap, and various trimming and ornamentation


1 2 3 4 5 6 7 8 9
10 11 12 13 14 15 16 17 18 19 20
6 21 22 23 24 25 26 27 28 29
30 31 32 33 34 35
36 37 38 39 40

TEXT-FIG. vi.

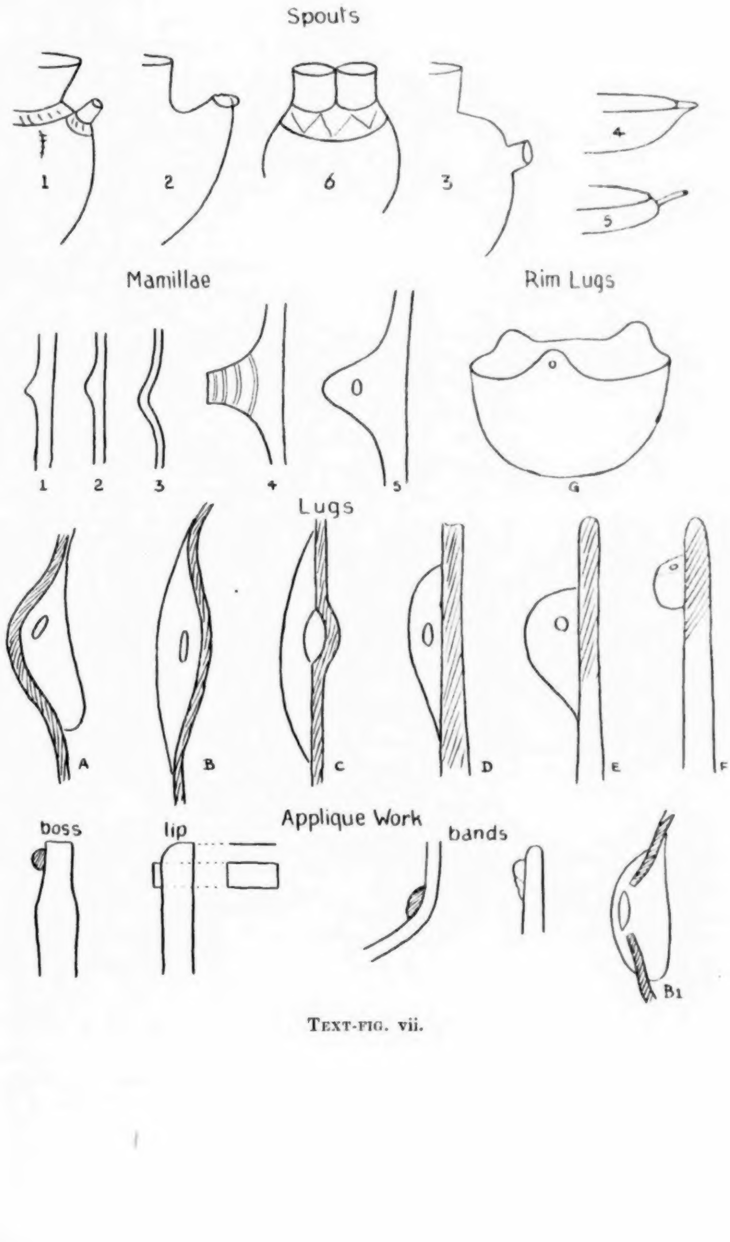
(text-figs. vii and viii). Necks vary widely in shape from contracting or inward sloping, vertical or bulged, to splayed, and ornamentation is varied (text-figs. v and vi). The neck-body junction method of consolidation must be noted—the angle of neck to body, trim marks, ornamentation, and any special treatment such as by applied clay bands. The body may be round, cone or ring based (text-figs. vi, vii, and viii), and each of these may be combined or not with shouldered neck. Body surface presents ornamentation, colour burnish, fire mottling, and incised patterns, or even appliqué work or repoussé work, or it may be crackled. Of these, fire mottling and crackle are not specially sought by the South African native potter, ancient or modern.

Great body thickness is characteristic of modern Bantu beer pots. No Bantu potter ever attains the delicate thinness of the finest Hottentot wares.

The various forms of bases (text-figs. i, ii, iii, and iv) depend in part upon the technique of manufacture. The rounded bases of Bantu pots (text-fig. i, Nos. 1–12) are divisible into three classes: (*a*) globular; (*b*) semi-globular; and (*c*) saucer base (No. 10). In No. 1 the semi-globular base is made first and the upper half of the pot built upon it. In pots of the form of No. 7 the whole body is raised in a single process and the neck forms a continuation of it. In No. 13 the shouldered neck is added to the bowl-shaped base as a second part of the building process. No. 20 is a simple bowl form, the sides of which are exaggerated. This form varies from the small drinking-bowl a few inches in diameter (text-fig. ii, No. 6) to the large pot, 18 inches or more in height (text-fig. i, No. 2, and Plate XVII, No. 14). The drinking-bowl is further adapted into goblet forms (text-fig. ii, Nos. 13, 14, and 15), which are based on the shape of the calabash goblet (No. 13), such as is still used by the Bahurutsi of the Transvaal.

The platter (text-fig. ii, Nos. 7–12) is an adaptation of the bowl for use with solid foods, and is flat based or slightly convex.

To-day the Zulu, Pondo, Xosa, Bahurutsi, and Basuto flatten the bases of their pots (text-fig. ii, No. 19) in imitation of European wares, and also because of the greater need for stability induced by imported goods. The flat base is now becoming general. Lewanika's nephew, north of the Zambesi, used a native-made cup of European type (text-fig. i, No. 15). The Basuto, one of the most artistic tribes, has evolved a pedestal base for the drinking-cup (text-fig. i, No. 18). The flattish bases of Bushman pots is not deliberate, but is due to their inability to prepare clay correctly (text-fig. iv, Nos. 1, 12, and 21). The Bahurutsi splay base (text-fig. ii, No. 5) is not modern, but their use of the ring base is (text-fig. ii, No. 5). Their pot covers with projecting mamillae, similar to the amphora-


Spouts
1
2
6
3
4
5
Mamillae
1
2
3
4
5
Rim Lugs
G
Lugs
A
B
C
D
E
F
Applique Work
boss
lip
bands
B1

TEXT-FIG. vii.

like base (text-fig. ii, No. 4) is traditional, and so also is the saucer-shaped cover. In fragmentary form the saucer cover is difficult to distinguish from a platter, and the cover handle from a mamilliform base. The cover, however, is not worn; the base usually shows traces of wear.

The modern Bechuana and Basuto make pots with projecting legs (text-fig. i, No. 17) imitative of the imported three-legged iron pot.

Pot body forms among the modern Basuto include also heads, finely modelled from elongated bowls, of which the base forms the head and the mouth the base, and flat-based jugs, of which the walls are moulded in Toby jug manner into human features. These all appear to be recent innovations, though the head is of similar technique to a pot found at Zimbabwe by Posselt (B.) and attributed to a separate class by Frobenius.

The rim, more than any other portion of the pot, is affected by shortage in or overplus of material, and by the idiosyncrasy of the potter—careful, careless, or merely inexpert. Within the two main methods of neck formation (built as a separate portion and added, or built direct on to body) there is wide variation. The lip may be slightly flared without the presence of a neck. The lip flare may be exaggerated and broad, so forming a definite neck (text-fig. i, No. 2), or flared acutely (text-fig. i, Nos. 3 and 4) as in Baghatla and Bechuana pottery. The gracefully curved neck (text-fig. ii, Nos. 1 and 2) shades gradually into the vertical neck with acute shoulder (text-fig. ii, No. 3) within the same deposit of the Zimbabwe Age building culture. Hottentot pots vary to the flare side or inward slope side of the vertical, and include also acutely shouldered pots which are neckless (text-fig. iii, Nos. 1–8). Other special features, *e.g.* the thinness, cone base, burnish, and lug, serve to differentiate the Hottentot from the Bantu products.

Necks receive special treatment. The string marking of the Hottentot pot (text-fig. ii, No. 2) is distinctive. Equally distinctive of a phase of the Zimbabwe period building culture is the applied band at neck-body junction, ornamented or plain (text-fig. v, No. 4). The depth of the Bantu vertical neck is variablé; the older forms of the building culture pottery usually have a flared lip, in one instance the walls are bulged outward (text-fig. v, No. 3).

The lip, the actual edge or rim of the pot mouth, receives varied treatment. In its simplest form it is plain and tapered (text-fig. vi, No. 1). In Hottentot pottery it is flared, turned over, consolidated, and trimmed (text-fig. vi, Nos. 3–5 and 6 *bis*). In Bantu pottery it is rarely turned over, though rolled lips, probably added as a roll, occur during the Zimbabwe period (text-fig. vi, Nos. 27, 28, and 29) at Khami and Zimbabwe. On other stone-building culture sites moulded forms of lip are common during the early phases (24), and in later phases may have added bands providing

a base for florid (text-fig. vi, No. 32) or symmetrical ornamentation (Nos. 31, 34, and 35).

Cracked pots were, and still are, in Basutoland, laced together with grass twine passed through holes bored on either side of the crack, such repair also occurred among the Makalanga and Bushman (9).

The variation in size and shape among Hottentot pots is slight, being confined to ovoid, globular, and spouted globular pots (text-fig. iii, Nos. 1-9). They do not appear to have bored holes in pots to repair them. Among Bushman products, except those in close proximity to Bantu, there is still less variation, and small bowl types predominate (text-fig. iv, Nos. 10, 16).

Among the Bantu there is great variety, with an occasional highly differentiated type. The various types are:—

Large beer pots: size, of many gallons capacity: used by Bavenda, Bahurutsi, Baronga, Basuto, Zulu, Swazi, Pondo, Xosa, and found also on ancient sites.

Large beer pots for carrying: size, two or three gallons; used by Bavenda.

Water pot, large: used by Bahurutsi, Basuto, Zulu, Pondo.

Water pot for carrying, with narrowed mouth, Swazi.

Cooking-pot: size, about a gallon capacity; used by Bavenda, Bahurutsi, Baronga, Basuto, Zulu, Swazi, Pondo, Xosa.

Small cookers: used by Baronga.

Platters: flat; used by Bavenda, Bahurutsi, Basuto, Zulu, and found also on ancient sites.

Wide basin, or platter: used by Swazi.

Tobacco grinders: a bowl with serrated inner surface; used by Bavenda.

Man's shallow wash-basin: used by Bavenda.

Necked pot for face washing: used by Baronga.

Small drinking-bowl: used by Baronga, Basuto, Zulu, Pondo.

Large drinking-bowl: used by Swazi.

Pedestal based drinking-cup: chalice shaped; used by Basuto.

Saucer-shaped cover to pots: used by Bahurutsi.

Small-mouthed globular pots are used in the Northern Transvaal for seed storage.

Multimouthed pots (text-fig. vii, No. 6) are occasionally made by the Zulu, and frequently by the Venda.

Spouted pots, with the spout springing from the shoulder (text-fig. vii, Nos. 1, 2, and 3), are found only on certain Gonaqua Hottentot sites (23), and rarely on other sites (55).

Spouted basin: a single spouted tetina or feeding-cup type has been found on a Rhodesian ruin. Unfortunately there is no other record attached to it (B.M.) (text-fig. vi, No. 5).

Bar lips: that is, a spout of the moustache-cup type, with the pot wall pressed out into a spout below, and the lip forming a bar above; have so far been found only at Mapungubwe in the Northern Transvaal.

Lugged pots fall into three classes: Bantu, Hottentot, and Bushman. The varieties are dealt with below.

Lugs are carefully designed and complicated constructions to give means of suspension (text-fig. vii, A, B, C, D, E, F, B1). Mamillae are more or less purely ornamental (text-fig. vii, Nos. 2, 3, and 4). The parts of a lug are the pad or reinforcement shown unshaded in A, B, and C; the bridge or wall between the apertures, the projection of the bridge, and the channel, which in the best finished types is burnished smooth.

Lug Type A (text-fig. vii, A).—The pot wall is bulged out, usually at the pot shoulder, and reinforced internally with a pad of clay, carefully incorporated with the body walls; two holes are cut in the pot wall, and a channel is worked through the pad horizontally from either side, either by finger or a wooden skewer.

Types B and C.—These are rarer forms in which the pot wall is bulged inward and the reinforcement is applied externally, the channel being moulded over a twig (text-fig. vii).

*Type B*1.—The stud was described by Peringuey (18) as the only method of lug formation (text-fig. vii, B1). It occurs very doubtfully except as a method of repair.

Type D.—The externally applied lug is crude in form, varying from an oval pat to a mere handle or vertical disc, as in E.

Type E.—These are crude and of poor finish. They occur in South-West Africa, grooved on the outside edges, and vary from a semi-shield to a semi-disc. Some approach the mamilla in form and are hook- or horn-shaped.

Type F.—Cylindrical or mamilliform lug, externally applied and perforated vertically (Type VII, F).

Type G 1 (text-fig. xii).—Lip or rim lug; a projection vertically of the pot rim, and perforated from without inwards.

Type G 2.—Projecting lip, imperforate.

Type H.—Handle type (Plate XII, 8). This is a band of clay broader than a cup handle, externally applied in a similar manner, and consolidated at either end with pot wall.

Type I.—Mamillae; vary from mere pips externally applied (text-fig. vii, Nos. 1–5) to repoussé bosses. The former are all externally applied or worked on an external slip. They occur on Bantu pottery or in pottery of peoples in close contact with the Bantu.

Mamillae are common on the pottery of several stone-building culture sites, and are otherwise found only on Late Hottentot sites as the result

of Bantu or stone-building culture impacts. Makalanga of mid-nineteenth century (21) used bosses, female breast patterns predominating, which fell into desuetude by 1890.

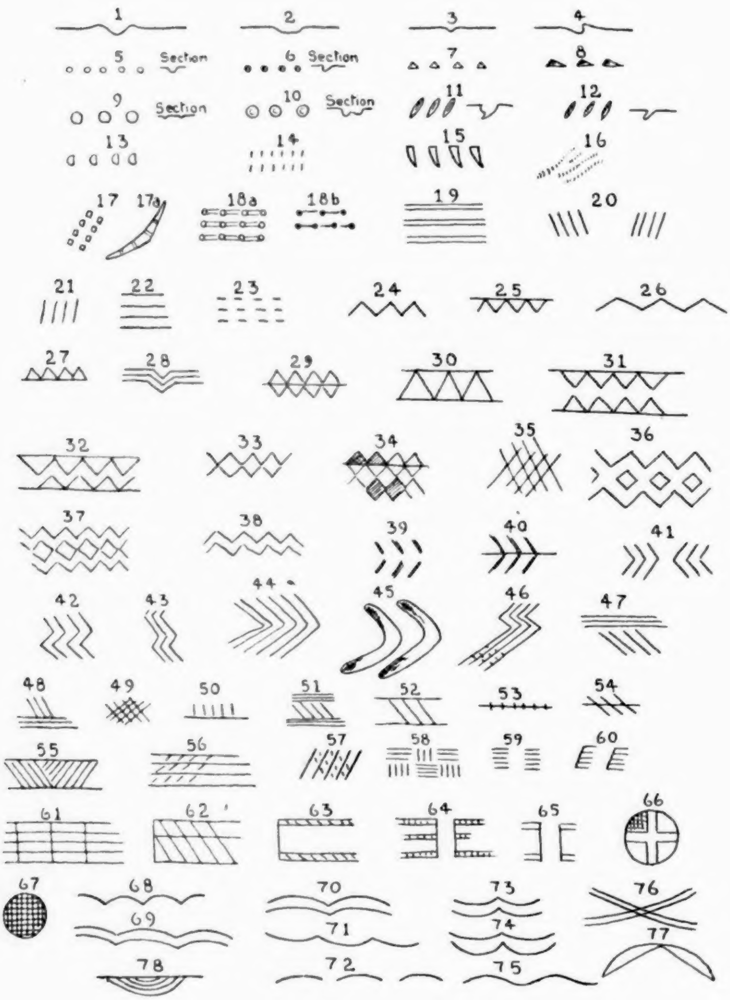
Section V. Ornamentation and Burnish.

No true glaze occurs on native ware, ancient or modern, in South Africa, and the term "burnishing" should be used. A burnish may consist only in the preliminary polishing of the raw pot by hand or leather and water, which may be followed by a pre-firing burnish of red haematite or black plumbago; a post-firing colour burnish is uncommon and impermanent, flaking off under the stress of use.

Pottery intended for good serviceable use was frequently (as it still is) ornamented by colour burnishing, incising, appliqué work, repoussé work, painting. The Mashona (10) burnish their pottery with plumbago. Among the Basuto the girl's drinking-pot is plain, the boy's well ornamented, on the principle that everything in life belongs to the man. In Pondoland pottery is blackened by smoking with goat dung. The only one instance is a colour obtained by vegetable colouring (3). Among the Baronga perfect pots are painted a brilliant brown with a decoction of mangrove bark, and of *akanye*, boiled with a creeper *mahbeblwa*.

The addition of a slip—that is, a softer almost liquid clay—applied to the outer surface of the pot is uncommon in South Africa, except in a few rare instances to produce a red surface in Bantu pots, and on Bushman pottery of the Queenstown-Tarkastad-Aliwal North area (23). The application of bands is, however, common in the stone-building culture areas, at Heilbron (24) and in Southern Rhodesia. Pseudo-appliqué work, or more correctly repoussé work, has so far been found only in the Gonaqua areas (Plate XIV, No. 12). Modern Bechuana and Baghatla burnish pots with graphite obtained from native mines. Zulu taste also runs to a dense black in under-fired pottery, assisted at times by black boot-polish. The outstanding example of self-developed art is that of the Basuto, who, to incised patterns, to-day adds polychrome effects in green, yellow, white, or red paint.

The commonest method of producing ornamentation is by incising, scraping, or pricking. Incised patterns are produced wet, that is on the raw pot, or dry on the burned pot, when of necessity sharp metal instruments were used. There is no evidence to support the use of stone chips for this purpose (25). Dry incision occurs only on the pottery of metal-working peoples, except that the Bahurutsi use a special instrument, metal or stone, for pre-burnish incising.



TEXT-FIG. viii.

Text-fig. viii illustrates diagrammatically the commonest simple forms that are used in ornamentation singly or in combination to form patterns, and is a basis on which any African ornamentation in incised lines may be described:

1. Section of wet vertically incised ornamentation showing the burr formed at either side.

2. Section of wet scraped pattern, wider, and with no burr.

3. Section of dry incised—that is, incised post-burning with sharp metal instrument—the groove is angular and shattered along its edges.

4. Wet undercut incision, *i.e.* incision with cutting instrument held at an angle.

5. Simple, vertical, prick mark; with section, vertical.

6. Diagonal or undercut prick.

7. Vertical, impressed triangular mark.

8. Diagonal, impressed undercut triangular prick.

9. Vertical, circular, ring impression, a sunk impression with central boss, produced by hollow reed in ancient pottery, by metal tubes in the modern (*e.g.* rubber container at end of pencil).

10. Vertical, circular impression by solid cylinder, in which central boss is only rarely present.

11. Finger-nail impression; this is always undercut, and shows nail and finger pulp marks separately, as in the accompanying sections.

12. Oval left diagonal (*i.e.* falling to left) impression formed with wood or bone spatula.

13. (*a*) Half round, vertical impression; (*b*) may also be undercut; or (*c*) with diagonal chord. A flat-ended stick of this form was found in a Bushman shelter in the Stormberg (8, p. 91), where this pattern is common.

14. Simple short vertical incisions, arranged in parallel lines.

15. Cuneiform incision, arranged in line or lines.

16. Bangle impression; short, curved lines, impressed by means of wire bangle, stated to be used by Bushmen. The appearance in Plate XVI, No. 6, is misleading, and is probably a string impression (8), but so far no authentic example has been found. It occurs only in Early African, pre-Zimbabwe pottery, where it is in parallel diagonal lines, and in the pottery of Mapungubwe.

17. Square vertical impressions formed by means of comb—that is, comb impressed.

17 (*a*). A curved comb pattern, the comb teeth being shallow and deeply impressed.

18 (*a*). Prick-and-drag ornamentation, multiple impressions in regular parallel lines formed by use of comb—that is, comb applied in a prick and dragged to right. Process reversed is drag and prick.

18 (*b*). Prick and drag, by simple point, the pricks on the various lines do not coincide to form columns.

19. "String marking": horizontal and parallel around the neck, which may be (i) incised; (ii) scraped. So named because of its string-binding appearance, with which, however, it appears to have no relationship. It varies from the finest regularity to the crudest short-line incisions.

20. Simple diagonals, falling to the right and falling to the left, *i.e.* right diagonals and left diagonals.

21. Left diagonals incised or scraped, as case may be.

22. Horizontal continuous incised lines, parallel.

23. Horizontal interrupted parallel lines.

24. Incised or scraped, line dancetté.

25. Suspended triangles, *i.e.* line dancetté beneath horizontal line. Though the origin of both is similar, subsequent treatment makes the term "suspended triangle" the more descriptive. Triangles usually approximate the equilateral form.

26. Line dancetté, wide angled, uncommon.

27. Supported triangles.

28. Parallel lines, indented, suspended.

29. Combined suspended and supported triangles in lozenge pattern, *i.e.* retaining horizontal central base line.

30. Counter triangles, *i.e.* line dancetté between two parallel lines. This occurs only in ornamental form, and the latter term expresses the technique of formation, the former the visible result.

31. Suspended and supported triangles opposed.

32. Suspended and supported triangles, interdigitated, in which subsequent decoration deals with the triangles.

33. Dancetté lines opposed to form lozenge pattern: uncommon.

34. Complex pattern of combined supported and suspended triangles, with opposed lozenge pattern formed of dancetté lines; upper triangles and the lozenges below, filled with left diagonals. All lozenge forms are late in origin and are formed by two methods—the above, or as in No. 35.

35. Superposed diagonals, left and right, forming lozenge patterns, Plate XVII, No. 17.

36. Dancetté lines bordering a simple discrete lozenge pattern in one line or band.

37. Dancetté lines bordering a simple continuous lozenge pattern in a single line.

38. Parallel dancetté lines, interdigitated to form a continuous chevron pattern.

39. Conventional herring-bone design, spineless, formed by upper right diagonal and lower left diagonal (26, pl. xvi).

40. True herring-bone design formed by diagonals as in 39, supported on and suspended from horizontal line or spine.

41. Reversed spineless herring-bone, with interval.

42. Right three-line stagger (named from uppermost diagonal which controls design), continued horizontally.

43. Left four-line stagger, alternating short and long.

44. Spineless herring-bone, better described as a two-line stagger.

45. The same, scraped with a broad implement and undercut at ends.

46. Left three-line stagger; diagonals of varying length, third line incised deeply over right diagonals.

47. Horizontal lines with suspended right diagonals.

48. Horizontal lines supporting right diagonals.

49. Combined right and left diagonals, closely incised, forming fine hatching.

50. Horizontal line supporting short verticals.

51. Horizontal parallel lines enclosing right diagonals, so forming a band pattern.

52. Band pattern formed by two horizontal lines enclosing right diagonals.

53. Horizontal, vertical, or other line crossed by short verticals.

54. Horizontal, vertical, or other line crossed by A (as shown), right diagonals; B, left diagonals.

55. Band pattern, two lines containing right diagonals, alternating with left.

56. Horizontal lines incised over less deeply incised left diagonals, forming a distinctive pattern.

57. Left diagonals over less deeply incised right diagonals.

58. Horizontal and vertical lines arranged in basket pattern.

59. Columns of horizontal incised lines.

60. Left diagonals with horizontal comb lines to right.

61. Band pattern of several horizontal lines, and regularly and widely spaced vertical lines.

62. Band pattern, butt-ended with vertical line, filled with widely spaced right diagonals.

63. Band pattern, an upper and lower narrow pattern 52, butt-ended with vertical line.

64. Band pattern, opposed butt ends, three equally spaced subsidiary bands of pattern 52.

65. Band pattern, opposed butt ends.

66. Circle enclosing cross, with hatched field between arms.

67. Circle, hatched field.

68. Simple meander, upright.

69. Band meander, *i.e.* lines parallel, upright.

70. Lunate meander, upright.

71. Simple meander, reversed.

72. Simple interrupted upright meander.

73. Band meander reversed.

74. Lunate meander reversed. No. 68 may be suspended or supported on an incised line.

75. Sinuous line.

76. Crossed curved bands.

77. Upright opposed crescents (26, pl. xxxv).

78. Suspended multiple lunates. Text-figure illustrates diagrammatically some more complex patterns.

79. Parallel and vertical incisions used for their relief effect in the production of raised squares or oblongs. A pattern that has had a long vogue from Early African at Dithebyane to Mapungubwe. A distinctive feature of western deposits.

80. Combination of 79, with a band of right staggers.

81. Incised line in which a prick-and-drag effect also is obtained.

82. Band pattern, of horizontal incised lines with left diagonals.

83. Band of multiple horizontal lines, containing crossed diagonals.

84. A simple band pattern of horizontal lines and left diagonals. From this onward, more modern complicated patterns are represented.

85. A broader and better band effect than in 83.

86. The butt ending of this pattern is distinctive of South-West Africa.

87. Counter triangles filled with diagonals.

88. An unusual band effect, South-West Africa.

89. The Herero tassel, hanging from a suspensory cord, is represented in incised lines. One of the very rare imitative designs found on South African native pottery.

90. Basuto wall pattern, indicating vegetable growth, and a "plenty charm," which may be connected with band patterns on pottery.

91. A filled triangle, bordered by a band.

92. A simple band, from Chiwona ruin, Southern Rhodesia, also found on the south-east coast.

93. An unusual modern effect produced by freehand incisions.

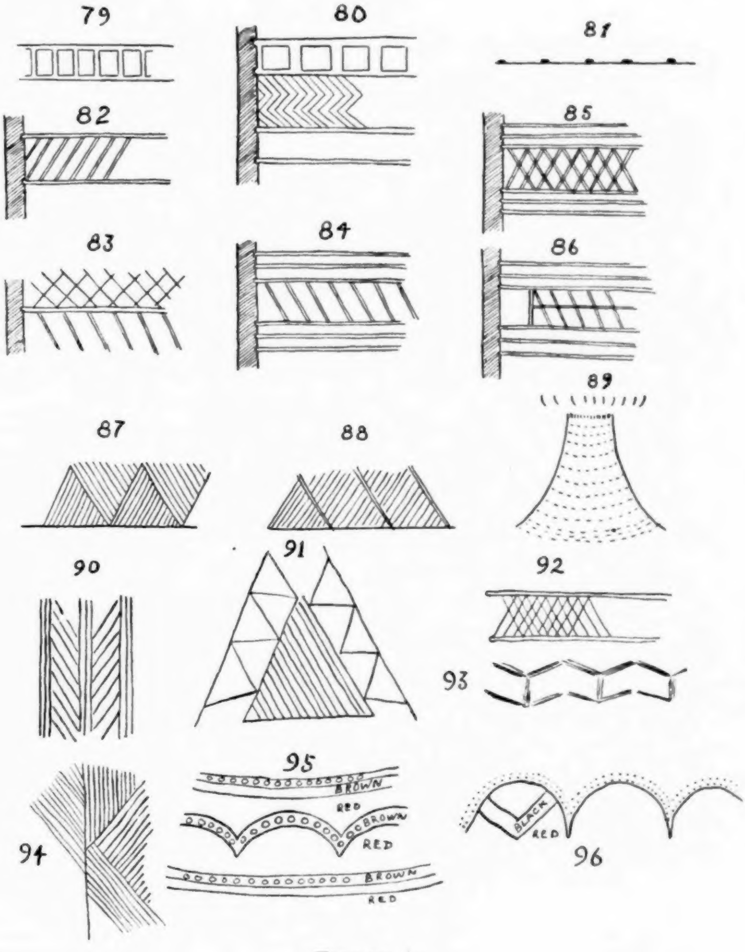
94. An unusual modern effect produced by varying the direction of straight incised lines.

95. A modern band pattern, including the band meander and impressed circles and bichrome.

96. A modern pattern, simple upright meander, bordered with impressed dots, and containing a suspended chevron.

All these patterns are applied with varying degrees of skill and depth.

In ill-finished, degenerate, coastal pottery they may appear as rough scrapes. On the other hand, scraped patterns may show great skill and



TEXT-FIG. ix.

care. Ornamentation by the addition of bands, plain or moulded, is considered under lips in section.

These patterns may be roughly classified under headings as follows:—

Hottentot.—Nos. 5, 6, 9, 10, 11, 12, 14, and 15.

Ancient.—Nos. 7, 8, 9, 15, 16, 17, 18 (*a*) and 18 (*b*), 19, 20, 21, 22, 24, 25, 27, 28, 29, 30, 31, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 60, 61, 62.

Bantu.—Modern—Nos. 9, 10, 18 (*b*), 20, 21, 22, 28, 66, 67–78.

Bush.—Nos. 13, 14, 62, 63, 64, 65.

Bushmanised Bantu.—Nos. 11, 12, 13, 26.

Bush with Bantu Influence.—No. 11.

Degenerate Coastal Bantu.—Nos. 51, 82, 83, 85.

Combination of triangles, whatever their subsequent treatment, are essentially Early African, or Bantu (text-fig. x, Nos. 97, 107), and crosses, circles (text-fig. x, Nos. 105, 106), modern Bantu.

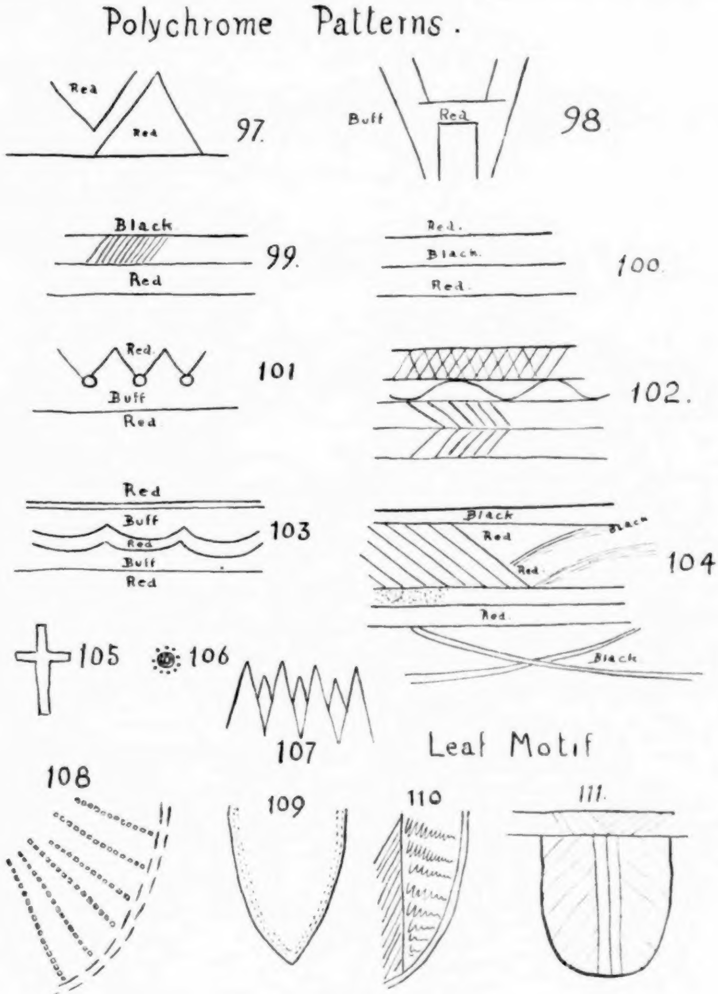
Squared patterns are equally characteristic of the Bushman, though they occur also in South-West Africa among the Hottentot and Bantu tribes.

Modern Bantu incised ornamentation is either careless (text-fig. x, No. 103) or inartistically complicated (text-fig. ix, No. 96; text-fig. x, No. 104), in which trend the Bantu unconsciously parallels the European. The cross, the circle, and freehand "pencil end" incision are all modern innovations.

Large groups of human beings possess patterns, and these become hereditary and national. All pottery was not ornamented; that of the chief and his family was, and such patterns became tribal. Thus there is a considerable variation between the details of ornamentation of one archaeological site and another, and of one tribe and another. The modern symbol of ownership is the owner's initials painted on the pot wall (Bechuanaland, P.W.L.).

More information is needed concerning the various tribal patterns and their use on pottery and other objects. The Basuto sleeping mat, *Mosemo*, has its own woven pattern. The Basuto mat for corn grinding, *setebe*, has its, and the mat upon which millet is ground for beer, also called *setebe*, has triangular woven patterns similar to pot patterns. The Basuto will not take food prepared on its incorrect mat. That patterns have a magical significance and that the sympathy is between pattern and supply is shown by modern Basuto pattern usage in huts, where walls are decorated with three vertical lines containing right and left diagonals, which is a tree and branch motif contained between vertical bands and is connected with agriculture and growth of crops. Its traditional significance is that the householders will never die of hunger (text-fig. ix, No. 90). It is the Basuto equivalent of the English sovereign on the watch-chain. Half-moons painted on one part and upright triangles (phallic triangles) on other parts of the internal wall are the expressed desire to have many

children. The triangle on pottery is, then, either a phallic-plenty or a leaf-plenty motif. If phallic, the Bantu use of pots for infant burial is



TEXT-FIG. X.

probably a corollary. A clay corner-cupboard is built in the modern square hut, for use by the childless mother; her utensils are not mixed with

those of the others. A wall pattern (Mokgatla) at Mochudi, Bechuanaland Protectorate, consists of, from left to right, horizontal lines, a left diagonal band enclosing a line dancetté, a triangle filled with right diagonals, the right basal angle meeting the base of a similar left band diagonal (text-fig. ix, No. 91). In the Transkei, among the Fingoes, there is still much ornamentation of house fronts with paint, distemper, or whitewash, usually a sign that the occupants are clothed or "civilised" natives. It is noticeable that all huts belonging to the same family bear similar ornamentation. These Transkeian wall patterns appear to be rarely met with on pottery, but they strongly suggest that pot patterns themselves originated as family marks and sympathetic magical designs.

The leaf motif commonly used in ancient Egypt was taken from the lotus and was usually upright (text-fig. x, No. 108). Very few specimens have been found in South Africa and they are mostly suspended (text-fig. x, Nos. 109 to 113), and can only be tentatively described as leaf motifs. It is quite possible that they are descended from the suspended triangle, and it is not impossible that certain triangle designs originated in leaves. There is a greater difference than merely the use of curved delimiting lines; the filling-in of the design is rarely that of the filled triangle, and consists of radial lines on specimens from Free State stone-building sites. In the beautiful Natal pots illustrated by Schofield (55) the filling-in of the design is nearer that of the triangle. There is a greater freedom of line in these decorations than in any other. There is least freedom in the stiff geometrical (though still artistic) patterns of Khami pottery (text-fig. x, Nos. 97, 98), attributed to the Baroswi (28). Both are distinctive, and both occur within restricted areas.

Banded bichromes do not appear to form a separate class, but are merely an adaptation of the band method of decoration commonly employed by the African, both ancient and modern (text-fig. x, Nos. 100, 101). Modern ornamentation has reversed the ancient procedure. To-day the Bantu uses angled and circular patterns (text-fig. x, Nos. 105, 106, 107), and polychrome effects are common in Basutoland, Selungwe District, Southern Rhodesia (text-fig. x, No. 105), and in Bechuanaland.

Section VI. Potting, Metal Working, Modelling, and Cotton Spinning.

The potter's art has a male aspect to it, that of metal smelting, clay furnace building, and tuyere making. These activities will be considered in detail in a separate monograph.

Clay modelling is an art commonly practised by all African natives, and the commonest objects made are children's playthings. At Heilbron

(24) three clay animals were found; also one in early deposits at Dithabyane, Bechuanaland Protectorate; one at Chiyimbwe, Southern Rhodesia, in the deposits of a kopje plateau settlement; and others at Zimbabwe (28), and at Vukwe (27) two clay birds.

Whorls were found in large numbers on the plateau excavations at Zimbabwe (28, p. 110) and by the present writer at Chibvumani. They were found at Dithebyane on the surface alone; at Mapungubwe throughout the entrance plateau deposits; at Dulsie in the Bechuanaland Protectorate; and at Birchleigh, Machadodorp. None was found in the late bushmanised culture nor in the earlier middens at Heilbron. That is, they appear to belong to the more northerly areas, and appear first during the Zimbabwe or late stone-building period, persisting until about 1860. The use of the whorl is probably the result of impacts from the north-east from more civilised nations during the stone-enclosure building period. The presence of whorls indicates at least a knowledge of spinning and thread-making. Eyed copper needles were found at Khami. De Barros (29) states that the King of Monomotapa would wear only such clothing as had been manufactured in his own country, which was (30, p. 122, quoting a writer of 1588) of linen and cloth interwoven with fine gold wire. Similar material has been found on the remains of a chief in M'Telegwa ruins. Dos Santos (29) states that in Mocarangaland a coarse cloth was woven, the women span, and that those who had dealings with the Portuguese wore cloth girt round the waist hanging to the knee. The Company of Jesus (29, viii, p. 234) found the inhabitants of the country beyond Sena wearing cloth and there was a large sale for it there. Willoughby (31) found natives using pot whorls for the spinning of bark fibres; and wild cotton, as late as 1892, grew in various parts of Mashonaland. Mackenzie (32) records that *circa* 1860 the Bechuana still wore home-woven blankets. Schonland mentions a soapstone whorl found at the junction of the Orange and Vaal Rivers 4 inches in diameter (A) (33). The presence of the whorl is undoubtedly a useful period indicator. During the Zimbabwe period whorls are more common towards the east, *e.g.* at Chibvumani, in later days they extended to Dhlo-Dhlo and are found spread widely over Northern Bechuanaland and the Transvaal.

Pottery amulets are of wider occurrence in area and time. Pot phalli, though probably of magical significance, are usually too large for wear. Specimens have been found at Zimbabwe (28), Lotsani, Heilbron (21), and in the pre-Zimbabwe settlement at Serowe.

Section VII. Pottery from Rhodesian Sites.

The present classification of Rhodesian pottery is based upon Zimbabwe excavations (28).

Type A, the earliest; coarse red-brown, to dark grey with a quartz admix, badly fired, rims flat and everted (28, pl. lxix), decorated with diagonal or other arrangements of shallow, square, or round impressions, was found in the hill-wash stratum, beneath pavements, and beneath all cement work; with the exception of a fragment at Dhlo-Dhlo, sub-cement and in daga mound II.

The daga mound find of A pottery suggests its use during, as well as before, the Zimbabwe period of building.

"A" pottery is quite different from "B" pottery and from ordinary native ware. It became "a thing of the past." It belonged, according to Caton-Thompson, to subordinate tribes—slaves, not proprietors! The plain fact is that it occurred in deposits of ash beneath buildings of the Zimbabwe period (28, p. 36); the usual argument of geological succession does not appear to have been applied. It will be shown that "subordinate tribes" must be replaced by something much wider and more independent in connotation.

Niekerk Ruins: "Places of Offering."—Randall MacIver was the first to describe this pottery, which he found at the Niekerk ruins in deposits named by him "Places of Offering" (26), 1·5 metres above the stream bed, in heaps 2·5 metres in diameter, and a metre in depth. On the same area, though above the level of the "Places of Offering," were cairns of stone with ash, doubtless more recent examples of the initiation school rubbish heaps, which both certainly represent. The writer was unable to trace the pots described by MacIver (26, p. 32), which he states were reconstructed at Bulawayo, so visited the site during 1933, and could find no evidence whatever tq suggest a connection between the rubbish heaps and the ruins. The "context not suggestive of equal antiquity" (28, p. 190) needs little explanation.

In the masses of pottery found among the lower and earlier deposits no ash was discernible. The ground had changed since MacIver's time, and there was no good section such as he described of masses of ash, pots, and bones, which is most suggestive, in a compact mass, of initiation school deposit. Middens from a settlement would be more widely scattered and be more fragmentary than either MacIver's or the writer's finds. In the ruins the ash was fresh and the pottery distinctly of a different type, as remarked by MacIver (26, p. 33). We cannot agree with MacIver and Caton-Thompson that the pottery of the ruins and of the open-air deposits is

essentially identical. It would be most unlikely that middens deposited by the inhabitants of the ruined settlement would be at such a distance from that settlement; further, the settlements themselves show much midden deposit within their walls. On the other hand, initiation school deposits in some number have been examined by us, and MacIver's description fits them with the one exception, that here the slight ritual was added of piling the pots together, unbroken. Such deposits are not made within sight of the home walls. The mass of pottery in these open sites is that described as "A." There also occur, however, fragments of a later flared neck, with diagonal scraped pattern, which is the pottery compared with certain Natal coast finds.

All pottery from the ruins is of a texture unaffected by age. That of the open sites is friable. That from the ruins would be classed by Caton-Thompson as "B" or "B1," and is similar to known late pottery in its burnish and the presence of added bands similar to those on the Que Que pot, and modern Bahurutsi pots.

There are then, in this area, three types and periods of pottery recognisable:

1. "A," for which the term Early African will be used. Pot forms include bowls (text-fig. ii, No. 6), platters (text-fig. ii, Nos. 9–12), and large pots.

The standard of workmanship is high in some specimens and low in others, and the lip shapes are characteristic of the deposits. The combinations of patterns are important. One lip shows horizontal bands.

MacIver found one unique fragment, not published, made in the form of an animal.

Our finds include:

One small thick-walled bowl, with quartz admix, diameter 4 inches, depth $2\frac{3}{4}$ inches, body thickness $\frac{3}{8}$ inch, is ornamented with right diagonals of square comb impression between horizontal incised bands.

A deep early site produced platter types 8 to 9 inches in diameter with squared lips and plain inward projecting lips (text-fig. ii, Nos. 9 and 11) with internal surface black burnished. On one the comb pattern is used vertically in close series. The lip is black burnished and there is black burnish between patterns. Small bowls of 4-inch mouth and 5-inch belly and $2\frac{1}{2}$ inches deep. Again, the facies is Early African, comb impressions are common in left diagonals, horizontal lines, contrasted black monochrome burnish occurs on the better pieces, while those without are of a cruder artistic finish, with more scraped than careful incised decoration. Lips are everted and flared or moulded.

2. Open site or surface deposits, coarse brown pottery, flared necks with an internal bevel bearing a scraped pattern, and scraped string

marked, and a vertical drag-and-prick pattern ending at the neck-body junction.

Our finds include this type.

3. The pottery of the ruins. The topmost hut platform on Kopje Two produced black-burnished ribbed ware of high finish. The surface finds made by MacIver were "rough and domestic."

Echo.—On the farm of this name, near Salisbury, are many Bushman shelters, and rock clefts utilised as Bantu burial places. Close by, standing free, over Wilton material were a number of pots, of distinctive design and belonging to the pre-occupation period (*ante* 1890). They included bowls and globular-bellied pots with short vertical necks and flared lips, similar to the ruins types, but with a comb prick-and-drag band at the neck junction and triangles filled red, contrasted against a partly black burnished body.

Salisbury Commonage Site.—Certain shelters on the Salisbury Commonage worked by Schofield (34) produced important stratigraphical evidence. The upper stratum of 4 inches of earth, which contained glass, was unfortunately rejected. Thereafter the material was found in three distinct strata:

A.—The uppermost and latest contained fragments of spherical, rough-surfaced pottery; plain, rounded, or slightly tapered lips, with neck ornamentation of "bangle impression" (text-fig. viii, No. 16), comb squares, and one fragment was black burnished.

B.—Contained less pottery; bangle decoration present, lips moulded externally. One fragment black burnished; the decoration described by Schofield as chevrons formed of dots, is better described as triangles supported on a base line of dots.

C.—Produced only one fragment, of rim, with thickened lip, with very definite left diagonals in square comb marking.

The whole deposit is Early African, has much in common with the early Niekerk deposits, and appears to be in close association with Rhodesian Wilton Stone Age. With this type of pottery the common use of the bangle impression and certain types of lip disappear.

Rhodesian Caves.—Many Rhodesian caves show signs of Bantu occupation. Of the Bambata cave in the Mattopos (36) the surface to 6 inches down is described as Late Stone Age (Wilton), but the Rev. Neville Jones's excavations produced sherds from the superficial ash; thick, well-burnished, and red, water-burnished, with the coarse scraping trim marks showing, lips thickened externally (Plate X, 1, 2, 3, 5, and 6) in peculiar manner; in some sherds there is a tendency to internal thickening also, suggesting that the lip was added to the body. Patterns include vertical incision on lip, which are in one fragment carried over the edge of the lip, with prick and

drag beneath (Plate X, 5), and beneath this "basket work" incisions. These deposits also produced a spout (Plate X, 16), and Mr. Neville Jones says he has never seen any similar spout from any other locality.

Gulubahwe, Madiliyangwa, and Whitewater are all three shelters in the Matopos excavated by Neville Jones, containing Wilton culture beneath an ash layer filled with Bantu relics. The first named produced thick (1·1 cm.) sherds with quartz admix, with drag-and-prick pattern. Whitewater produced an imperforate whorl 6 cm. diameter and 0·7 cm. thick, and lips again of peculiar type. The patterns produced include staggers in square comb impressions, herring-bones, and left diagonals of square comb impressions on lips, with drag and prick below the lip.

The Madiliyangwa relics were reported upon during 1932 (37). The sherds, seven in number, are identifiable as:

1. Fragment of a vertical-necked pot, neck-body technique, mouth 5-inch diameter (with considerable encrustation on surface and edges), lips everted, consolidated and ornamented with a succession of left diagonals in square comb impressions. The lip is bevelled internally and carefully trimmed. The neck surface is ornamented with successive horizontal lines scraped with a blunt-pointed instrument, its circumference being treated in sections in drag and prick.

2. A fragment of rim, peculiar in that the lip is trimmed within to a step, and the outer overlap has the appearance of a slip. This has been ornamented with plain diagonal lines on rim, with a single row of impressions beneath.

Another sherd is more coarsely made, has considerable quartz admix, and the body is laminated, its inner surface roughly water-burnished, outer roughly water-burnished, and thereafter colour-burnished. The lip is bevelled internally, and externally has a slightly rounded overlap; there is a single scraped line about $\frac{3}{4}$ inch below lip edge. The sherd edges show no limy encrustation, which may indicate a later date of introduction. A similar but claret-red burnished sherd is ornamented with close-set lines of semicircular impressions made with a round, flat-ended stick. Another shows ornamentation of an unusual pattern, a vertical fluting, the result of deep scraping.

Similar sherds have been found at Que Que (N.J.), and other "A" sherds, over Wilton deposits and associated with a cement floor, at Gokomere Cave (28, page 63, note 2).

The Mumbwa cave near Broken Hill in Northern Rhodesia produced pottery in its superficial levels (38, pl. xxxii): very occasionally pottery was also found at deeper levels, especially towards the cave walls (*ibid.*, p. 388). Unfortunately little attention appears to have been paid to the sherds in this most important deposit, and there is no evidence concerning

the association of the lower sherds, nor was much retained (W.W.R.M.S.). Generally the finish of surface is good, plain burnished, in colour brown to grey brown. The pottery from the superficial or iron arrow-head stratum shows squared lips, and round; patterns 24, 42, 43, 44, and staggers of five lines. Suspended and supported triangles filled with dotted diagonals, bangle pattern in a sherd well finished with red burnish, regularly arranged horizontally, and in right diagonals, alternately; meander short, made by double application of a cuneiform-ended stick; comb patterns one fragment with whole surface so ornamented.

Termites and tree roots had been responsible for some disturbance, and possibly the burials also were responsible for some. The iron smelters' deposits with the upper layers of which the Early African sherds were associated, and also with Wilton, were considered pre-Bantu. Since the publication of that paper, however, these lower slag deposits have proved not to be slag.

We are quoted as supporting the existence of a non-Bantu Wilton culture which embraces pottery "whose inspiration may have arisen in pre-Dynastic Egypt." Much time and labour has been given to elucidating the ceramic Stone Age relationship, and nowhere so far in South Africa has evidence been obtained to support an association other than the result of intrusion by early metal workers and potters into a Stone Age non-potting culture area. The strange similarity in potting method between modern Nama Hottentot and pre-Dynastic Egyptian is admitted, but to us conveys the essential African origin of all South African ceramic industry. There appears, therefore, no reason to claim for the Mumbwa sherds an age greater than the later phases of Early African.

Rhodesian Ruins.—Caton-Thompson states that the change from A pottery to B is sudden; yet records instances of its being found together, both above and below the pavement stratum. The fact that typical "A" pottery occurs at Niekerk, with partial black burnishing, explains the relationship which is that of direct evolution by invention or culture accretion. The gap (if any) in succession at Zimbabwe is due probably to a gap in occupation.

"B" pottery is described as of finer texture than "A," with a "black slip" on the outer face with a bright metallic and effective sheen, fired a red-grey and undecorated (28, pl. xviii, 2) lips—bevelled, slightly flared. The "slip" is a black graphite burnish. The resemblance to ordinary native ware is beyond dispute. This ware was abundant at the Maund ruins in the daga mounds, the humus around, and in the infilling of the court.

Type C was found throughout daga, in Chiwona middens, and one sherd

at Dhlo-Dhlo in post-cement positions, and was found *mostly* in the upper layers of the Zimbabwe Acropolis daga stratum and on the plateau, on the surface. It is thicker and coarser than B, brown and polished, of large vessels. Lip (28, pl. lxx, 2) moulding is more pronounced. In Maund Ruins, Mound VI, C sherds of large vessels occurred with B (28, p. 51). It is a sub-type of the makers of B, and certainly contemporaneous. Throughout the story of African ceramics plain pottery of proletarian domestic type accompanies that of more artistic finish, and on any one site, from the Niekerk "A" site onwards, the standard of finish may vary from that suggestive of a new apprentice's first work to that of a highly skilled and artistic potter. The latter was the standard for the possessions of the chief in his High Place.

Randall MacIver (26, p. 81) classifies pottery from Zimbabwe and the valley ruins as:

1. Rough, unornamented, household pottery, varnished with plumbago, and,
2. Wheel-made, unvarnished pottery, ornamented with geometrical patterns.

That so careful an observer could be misled into using the terms varnish and wheel gives some idea of the height reached by the native art of potting during the Zimbabwe period.

Chibvumani.—i.e. Caton-Thompson's Hubvumi, which is the name of another kopje, not that of the ruins planned by her. The characteristics of the pottery from these ruins are: homogeneity in finish, finely finished vertical necks (text-fig. ii, No. 3), which vary from 1½ to 4 inches in height, and with the black burnish carried down within. The shorter necks have a slightly poorer finish. The lips are in all cases well flared and almost at right angles to the necks; the neck-body junction is reinforced by applied bands of varying thickness and patterned with short vertical incisions in column and parallel, and a combination pattern. Much of the ornamentation has been made with a sharp point, and there is a greater variety and better finish here than on any other ruin in Rhodesia. A band pattern is common.

Large pots have vertical thick necks, with rounded lips, or are globular, with thick rolled lip (text-fig. v, No. 14).

Bowls of fair though plain finish are 3 inches high and 4½ inches in diameter. A few are unfinished in appearance compared with those of the average high level of attainment, and are thin in body. Sherd whorls are common.

Mchuchu (Caton-Thompson's Mshosho. We are assured by native commissioners that the former spelling is correct).—There have been two occupations of these buildings:

A.—That of the stone builders, the original.

B.—That of the makers of two cement-floored huts, uncovered by the writer during 1933, the midden of which covers the original ruined entrance steps.

The pottery illustrated in Zimbabwe culture (28) was found not in the middens, but lying free on the platforms of the kopje, and belongs to this later occupation. The large quantity of complete and broken pots on the surface could hardly have survived from the first occupation. They are similar in decoration (except for the lack of colour burnish) to the pots obtained from burials at Echo, near Salisbury, *i.e.* somewhat coarse and thick in body, with heavy quartz, which here may be natural admix, and much crackle, lips everted; and ornamented at neck-body junction by a two-pronged comb with a prick-and-drag pattern of a type that still exists among the Bavenda. A mamillated pot also was found, probably Makalanga of the early nineteenth century (P.W.L.). It is recorded that in the middens no black-burnished pottery was found (28), and the little pottery which occurred in the deposits was similar to that of Matendere. The exception is fragments of a flared neck, black-burnished pot of the building period, found by the writer below the level of the previous excavations.

Matendere.—Pottery is scarce and the general standard low; grey brown carelessly incised and all is in plain natural burned colours, a large-sized, possibly natural quartz admixture is present. Black burnish is scarce, two fragments, one described in (28), the other a sloping neck, with rolled lip (*cf.* Mchuchu), of poor black burnish, from midden deposit.

Another type of black pottery is unburnished, merely fire mottled; of this, one sherd was found with a sloping curved neck of the Mchuchu second occupation type.

Patterns: impressed triangles (text-fig. vii, No. 8) in a double line which occurs also at Penhalonga pits (W.W.R., 637), large circular depressions and left diagonals, supported by row of oval prick marks.

Chiwona is considered to be a later building than Zimbabwe (28, p. 128). Comb patterns are absent, burnished and unburnished wares are present, with patterns foreign to Zimbabwe, again a suggestion of local fashion or isolated development. The black burnish is not of the best, and not to be compared with that at Chibvumani, though superior to that of Matendere, the trimming striae on the pot surface showing through the burnish. A single piece of fine appliqué work, a frog in low relief, on a black-burnished pot was found (28, pl. xxxi, 1). Incised patterns include banded or contained criss-cross (No. 92), small and fine, the criss-cross being made with a sharp, the containing lines with a blunt instrument, a pattern that occurs

also in coastal Bantu deposits. Patterns of rougher execution, blunt scrapings, occur on sherds from the cleft midden, suggesting a second and late occupation. A vertical neck with applied band at neck-body junction, black burnished and similar to the type found at Chibvumani, was found by the writer. Pot spindle whorls occur (28).

Inyanga: Needle Kopje.—This is a tall needle-shaped pinnacle, on which every available ledge has been utilised for building hut platforms and in which entrance passages are lintelled. Behind the pinnacle tip is space for a single hut, and in its slight ash deposit black-burnished applied-band pottery was found, just as at Niekerk Kopje Two. In all other positions on this tenement-like structure the pottery was less well-finished and without bands. Necks are gracefully curved over globular bodies and there is a tendency to internal black burnish. Platter forms also occur.

Inyanga Pits.—These peculiar structures were first described by MacIver, and those of the Penhalonga area more recently by Mason (44). Each is essentially a pit surrounded by a platform on which a hut was built; the entrance to the pit being along a sunken stone-roofed passage. The architecture is distinctive and their distribution limited. In the excavation of one Mason found potsherds beneath and above the stone paving, which was identical. They were of finely prepared clay, to which finely crushed quartz was added, and the pot apparently was built by a successive ring technique. The relics show great variation in size. The majority are globular, with lips of varied degree of flaring, with only an occasional tendency to a vertical neck. An unusual specimen appears to be overlapped in the Hottentot manner, but the section shows it to be short, broad based, deeply trimmed, and acutely tapered. Though it is overlapped and consolidated, and though this is usually a Hottentot feature, this specimen cannot be called Hottentot in type. Most of the pottery is plain burnished.

Mason describes a thin yellow-brown incrustation as a decoration. Without handling it is not possible to say whether this is original or due to dampness. It was found in a water furrow. The shoulder of the pot is encircled by a double horizontal line of small triangular stamp impressions. Mason concluded that this pit pottery was quite distinct from the modern Manyika ware of the district, which, however, was paralleled by sherds from certain other crude stone structures in the district. It is extremely dangerous to dogmatise on similarities in or differences between assemblages of sherds which present few features of burnish, neck, base, or pattern. Mason takes MacIver's description of pit pottery: "The pottery is all made by hand, without wheel or lathe. The clay is a coarse, greyish earth, strengthened by the addition of powdered quartz, and the surface

is left rough, without slip or covering," and applies it to the identification of "Inyanga pottery" with that of the Penhalonga Pits, and states that the impressed triangular decoration of the pit sherd "is characteristic of the pottery from the Places of Offering, Inyanga district, and illustrated by MacIver in pl. xi." That plate illustrates typical Early African pottery. Nowhere in it can we find a triangular impression. Nowhere does MacIver mention one. The impressions are invariably square and comb impressed. Mason states: "It will be obvious from the foregoing that the Penhalonga and Inyanga pottery belong to one entity." This is a wild statement. The Penhalonga work was confined to pits and certain crude structures believed to be modern. The Inyanga area includes three distinct types of architecture with middens, and two types and ages of "places of offering"—a total of five periods.

The pottery of the Inyanga goat pits is red, poorly finished, thick, heavy, clumsy, with a quartz admix and much crackle; short vertical necks are not invariable; it is similar to that of the late ruin Matendere, which comparison does not, however, exclude it from being of still later origin.

Khami.—The "polychrome" ware, distinctive of Khami (Caton-Thompson's "D"), can be divided into two classes:

A.—Incised wet, geometrical patterns, worked in a red monochrome contrasted against a black fired background (text-fig. xi, Nos. 10, 9).

B.—Incised dry, with a metal blade; illustrated by Randall MacIver (26, p. 94). All surfaces are smooth burnished, and patterns are bold and may be further divided into:

B1.—Incised patterns without enclosing lines, *e.g.* a triangle formed of diagonals alone.

B2.—Colour burnished patterns within incised outlines.

At Khami, black-burnished ware, contrasted monochromes, and plain water-burnished wares occur in the same midden, including the patterns suspended triangles filled with vertical columns of four-pronged prick and drag. Pattern 56 is common.

C.—The Albany Museum collection contains fragments from Khami of the late type of prick and drag common in Late Rhodesian burials near Salisbury, surface deposits at Mchuchu, among the modern Bavenda, and which occurs also at Mapungubwe on the Limpopo.

From Khami also came a specimen (A) of black ware ornamented with double bands of opposed triangles, filled with left and right diagonals, a type common at Mapungubwe. Another specimen is ornamented with impressed inter-digitating triangles in vertical columns—a pattern so far recorded nowhere else (A, Plate XV, 10).

These may be listed as Khami A, bichrome; Khami B, black burnish,

possibly correlated with Mapungubwe on the south; and Khami C, a widespread, late pottery, possibly not made by stone builders.

Dhlo-Dhlo.—Contrasted monochrome pottery also is found on this site. Black, with geometrical patterns in red, and with incised decoration. The surface has a matt finish. Beneath the cement floor one fragment of Early African comb pattern was found (28). Pot whorls were found beneath the wall of a hut in the citadel (26, pl. xix). Long necks, everted lips are usual (28, pl. xliii).

In the Bulawayo Museum are preserved the pots found beneath the ruins of a burned hut (28), globular, vertical neck, rounded (non-flared) lips, mottled dun and grey by firing, and devoid of all attempt at ornamentation. The bases are darker, and the pots were therefore fired mouth up. They are poorly burnished though carefully finished, and were associated with beads of Class II (22), dated at about 1700 (28).

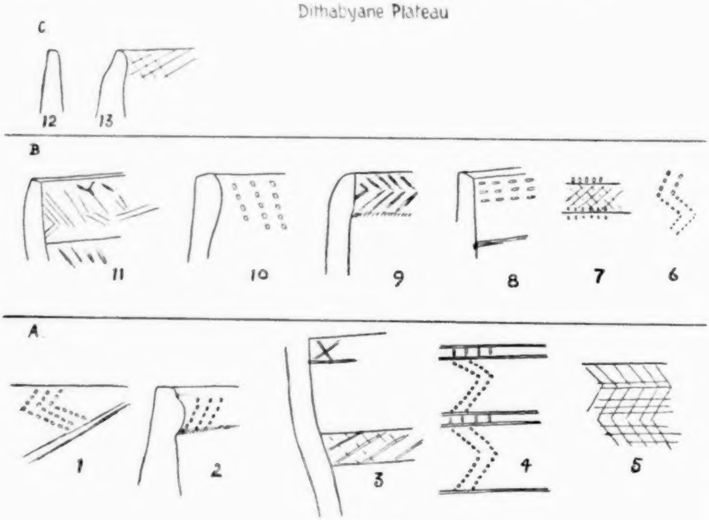
Section VIII. Bechuanaland Protectorate: Pottery from Ancient Sites.

During 1933 we excavated the Lotsani Ruins at the junction of the Lotsani and Limpopo rivers, and also excavated at Serowe Town Kop, Dithebyane Hill near Molepolole, and Maokagane on the Kalahari border. The details, other than ceramic, of these excavations will be published elsewhere.

Lotsani.—These ruins fulfil Caton-Thompson's definition of Zimbabwe culture. The sherds found include three fragments of true bichrome, red and black banded, lightly incised, with a lip concentrically grooved; a pot phallus; a slightly rolled lip type (21) (text-fig. vi), contrasted black monochrome, with a broad scraped pattern; red monochrome with a broad scraped pattern; and black monochrome. An unusual pattern is included, interrupted incised lines and one sherd was covered with prick marks which is similar to others from Mapungubwe in the Transvaal, also situated near the Limpopo and about eighty miles distant, and is also similar to one found at Umhloti in Natal.

Serowe town kopje is walled around and contains within ash to a depth of over 4 feet, over which are later stone structures. On the surface are found early imported glass beads (22); in the ash, none. The ash depositors were metal workers and used ostrich eggshell and metal beads; sherds are sparse, and include fragments of sloping-necked (text-fig. v, Types 7, 8, and 9) pots and one fragment of a goblet (text-fig. ii, No. 13), lips are thick, there is a tendency to applied bands beneath; flattened platter lips of Type 9, text-fig. ii, occur, and sherds of small bowls with everted lips. Patterns have been produced by the oval-ended comb

(Type 17*a*). There are also square comb impressions in right and left diagonals; the band formed by two parallel incisions and filled with diagonals of impressed comb squares is a favourite here. Prominent bands are a characteristic, and these may possibly be connected with the banded pottery at Inyanga and of the modern Bahurutsi. Bowl and platter lips (text-fig. ii) were found in the upper strata and comb patterns of Early African at the bottom. The whole deposit is of Early African facies, and distinct from surface finds of modern Bantu origin.



TEXT-FIG. xi.

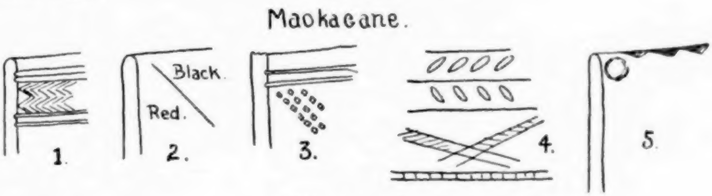
Dithebyane hill near Molepolole is an ancient walled kopje on which later stone builders also built, while in the valley below is a still later degenerate type of walled structure.

The latest, valley, structures contained coarse unornamented pottery indistinguishable from recent Bantu. The surface of the hill-top deposits produced a broken pot whorl and a fragment of contrasted red monochrome. The plateau deposits in their upper layers included sherds of contrasted monochrome, and three-line stagger patterns and small fragments of comb impressions enclosed between bands of squares (Type 79), generally coarse, with quartz admix. The middle and lower strata produced a greater proportion and variety of those comb impressions (text-fig. xii, Nos. 1–11), which usually are associated with Early African and contrasted monochrome patterns in brown and red. A bowl sherd has a

black burnished rim, a three-line stagger between bands of comb or incised lines, strikingly similar to those from the Mapungubwe deposits. This partial black burnish is a feature of the Early African deposits near the Niekerk Ruins. Pattern 5 is an unusual combination of staggers and horizontal incised lines. There is even a stagger in square comb work (No. 6). The tendency to moulded lips is marked.

The band of raised squares, formed by two parallel incised lines, with a series of careful vertical incisions, leaving raised squares (pattern 79) is also typical of the two sites, as also is the pattern composed of faint, scraped horizontal lines, crossed by deep left diagonals, suspended triangles filled with comb squares (pattern 57). Three-line stagger between bands of squares, incised, is a favourite pattern (Type 80).

Beneath this on the original ground surface were relics of the Late Stone Age.



TEXT-FIG. xii.

Maokagane is a large kopje plateau deposit of the iron workers, widespread, but not deep and apparently homogeneous. Potsherds are innumerable, and a considerable collection has been deposited in the MacGregor Museum, Kimberley (K., 1761). The patterns include prick and drag, square comb impressions, and oval-notched combs (17*a*), true herring-bone, *i.e.* spined; red burnish is well finished, and lips are ornamented by incisions, mamillae, applied bands, bands of three-line staggers, similar to the oldest at Dithebyane, though with a finer burnish. A few dry incised sherds were found.

The general characteristics of the ceramic assemblage are: extraordinary fine finish, a mixture of Early African comb patterns, and contrasted monochromes. On careful comparison of sherds the result is not so homogeneous as at first suggested, and the pottery falls into four classes:

A (text-fig. xii, Nos. 1 and 3).—Reddish buff body, plain water burnish, well baked. Incised triangles, filled with comb impressions. Three-line staggers, to right of comb impressed square or oblong (the latter made with a notched stick in which the notching is wide spaced); oval stick-end impressions, 2 cm. long, shallow, occur on red-burnished ware (text-fig. xii).

B.—Red burnished, sand admix, lips everted, edge trimmed flat, ornamented with diagonals right and left, to make raised lozenge panels; herring-bone pattern 39; two-, three-, and four-line staggers, oval impressions, and oval impressions with incisions over, pattern 80 a favourite.

C.—Red and black burnish, in bands and triangles (text-fig. xii, No. 2). prick-and-drag light incisions, angular patterns, one fragment dry incised.

D.—Ornamented with horizontal lines filled with prick marks, with meander pattern 69, filled with prick marks, and red and brown burnished, one fragment only. Nicked lip sherds.

A and B are probably contemporary and Early African, C is intermediate, comparable with Khami A and D, and is possibly later and intrusive.

Modaepae.—A high kopje near Mochudi, Bechuanaland Protectorate.

A.—Inter kopje plateau; midden deposit with fragments of tuyeres, and one sherd with square comb impression.

B.—Below A, on the hillside nearer the plain, are stone-built enclosures; which produced contrasted monochromes, red burnish contrasted against matt natural black; dull black burnish contrasted against natural red burned: one fragment of goblet base, prick-and-drag line as at Lotsani (Type 81).

Lobatsi.—A boguera or initiation school deposit on an exposed rock surface and covered with stones contained the remains of several pots, well made, unburnished, sand admix, lips nicked (Type 30, text-fig. vi). Very little ornamentation, and only one moulded lip type.

Section IX. Pottery from Transvaal and Free State Sites.

Mapungubwe is situated on the Limpopo, fifty miles west of Messina and about eighty miles east of Lotsani. Here potting was a fine art. Beauty and regularity of pattern is outstanding, and careful execution of simple patterns and their combinations has produced quite exceptional appearance. Black burnish, though not lustrous, is good; tall vertical necks occur, though sloping necks are more common. Bowl, platter, and goblet development is strong, patterns 57 and 79 are found on black-burnished and other pots. These patterns and the great use of staggers suggest connection with the west, while the drag and prick at neck-body junction appears to be ubiquitous in the east in recent times. Platters are common, and globular pots also. Spouted pots and small bowls of the bar-lip type (text-fig. vii, No. 4) occur in numbers; and the vertical perforated Type F, cylinder or mamilla, which is found commonly on Zulu wooden vessels. An imperforate specimen is surrounded by concentric circles of dots, and is similar to specimens from Gonaqua areas in

the south-east. A few fragments of neck show added clay, which with bored holes represent attempts at repair.

On sites to the south of Mapungubwe geometrical incised patterns combined with contrasted monochrome occur.

Machadodorp.—Extensive stone-built settlements at Birchleigh, Reitkloof, Waterval Onder, and Airlie produced three distinctive types of pottery:

A.—Coarse, unburnished, splay bases or cone handles of Type 5, text-fig. ii, associated with stone structures and similar to modern Bahurutsi pottery.

B.—Unburnished pottery, nicked lips, well made, certainly associated with stone building.

C.—Bichrome, red and brown, the colours separated by long, bold, dry incisions, with simple neck patterns, certainly associated with stone building.

Near Witbank a large imperforate mamilla has been found (S.A.M., 1387).

Aasvogelkop.—Near Johannesburg: no ash middens from the stone enclosures on this kopje survive, and only one bead, Class V (22), of doubtful period association has been found (W.W.R.M.S.). The potsherds (P.W.L.) were recovered by searching in the cracks and crannies between rocks where sherds would lodge during heavy rains. They include an intensely crackled sherd with left diagonals of square comb impression. A lip with two bands of L-shaped diagonals formed of square comb impression, another patterned on buff, a small drinking pot, everted lip, without bevel, five lines of prick decoration in colours and a pot, red surface, 3½-inch diameter.

Other sherds show faint traces of red and black burnish. One fragment has incisions on outer edge of lip. One specimen (W.W.R.M.S.) has a combination of square comb impressions, with contrasted red monochrome and interrupted line meanders, which are, with the incised lips, suggestive of Bahurutsi origin.

Zeerust Area.—On the farm adjoining Struan, near Zeerust, are the remains of the stone-built town Kurrichanee, inhabited by the Bahurutsi and named Chwenyane by them. It was described by Campbell (32) and was visited and partly surveyed by the writer during 1935. The local Bahurutsi claim that it is the kraal of their chiefs prior to the Mantatees raids of 1823 which wiped out most of the inhabitants of the district. This is not a faint tradition because on this occasion the modern native can describe the use of every part of the complicated plan (the architectural aspect of which will be discussed in a separate and forthcoming publication). The middens around the chief's great place produced a preponderance of ornamented pottery, other middens a preponderance of plain, and they

form an assemblage that can, on the evidence of contemporary travellers, without shadow of doubt be dated to the period around 1790 to 1823.

The pottery found includes everted but unthickened necks heavily ornamented with horizontal lines of impressed squares, and with, on the shoulder, suspended triangles formed by two lines of impressed squares, with the triangular area blackened or reddened, contrasting with the general body colour. Stopper tops, *i.e.* knobs from pot covers, fragments of shallow saucer-like pot covers, and a pot base fragment showing signs of wear. Associated with the area are flared necks with nicked lips (Plate XVII) and one fragment with a raised band.

The similarity between these ceramic remains definitely dated to not later than 1823, and Heilbron B, Aasvogelkop, Machadodorp, and Chwenyane material suggests that this pottery was made by the same widespread tribe, or a migratory one.

Dr. van Hoepen has excavated a similar site at Buyspoort, to the north-west (46), where he found much pottery of two types:

A.—Plain, rough, globular pots with slight neck and everted lip, much of which is extremely rough in finish, and includes small sizes, everted lips with squared edge, similar to the Heilbron "A" specimens (24), plain pots with nicked lips, and flat-ended amphora type bases, which he claims are from three-legged pots, though the angle of the base does not suggest this.

B.—Pottery, ornamented in incised lines, with prick and drag, and to a small extent with comb-impressed squares. The assemblage appears to be identical with that of Chwenyani.

We are quoted (p. 25) as suggesting that all pottery which contains coarse quartz particles belongs to a people among whom potting was a recent and imitative industry. The Buyspoort particles are, according to that writer's text, not regularly distributed and are large. It is hardly likely then that they are a deliberate admix. They are more probably of natural occurrence and indicate poor clay working.

Free State Stone-building Culture and Other Open Sites.—The *Heilbron* sites (24) of the stone-building, iron-, and bronze-working Bantu showed that the earlier style of stone building was associated with a finer and more Bantu-like pottery than was the later bushmanised occupation, and the pottery may be classified thus:

A.—Pottery, coarse, thick, amphora base and splayed base, or cover knob, surface finds of types found at Machadodorp, and belonging to late Bantu, probably Basuto or Bahurutsi.

B.—Pottery keeping the tradition of the small Bantu drinking cup, and the larger types of pot, but degenerated, coarse in body, at times vertical-sided. Definitely bushmanised, although still associated with stone building, and the Bantu custom of infant pot burial. Significant of

isolation of the culture for a period sufficiently long to allow cultural change (24).

C.—Coarse thick-bodied pots, everted lips, internal bevel.

D.—Plain unburnished globular pots, short vertical necks, with squared lips. Good finish and symmetrical. Red burnished surfaces. Stratigraphically earlier than C.

E.—Unburnished, black, coarse of body, with thick appliqué bands below lips, crudely worked by fingers, and associated with crude prick and incision decoration, one specimen reminiscent of a leaf motif; occurring in outlying middens of early structures only. Possibly contemporary with D.

F.—Contrasted monochrome, red burnish (Krugerskraal, P. 3) contrasted monochrome, brown burnish.

G.—Comb impressions, casual finds of Chwenyani type.

H.—Colour burnished, wide scattered and few. Divided into true bichrome, black and red and contrasted monochrome banded pottery. F, G, and H are probably contemporary with A.

The close-set half moon (Pattern 13) with the burr at the chord was found at Krugerskraal. Other specimens, casual, found at Ladybrand, and a specimen from Natal (S.A.M.), show this pattern in successive rows. From Koffiefontein, O.F.S., came a true finger-nail pattern (K. 1843), showing impression of nail and finger pad, worked into a herring-bone. A less well-formed pattern of similar type occurs around Queenstown and Tarkastad (23) of Bushman origin, and leads doubtless to the close pattern, over slip, of rows or columns of incised short lines, at Smithfield (S.A.M., 1838), horizontal lines in columns (S.A.M., 1836), a pattern that also occurs in the Vechtkop ruins (24), and at Norval's Point (49, A.), (P.W.L. and A.), Teviot (P.W.L.), Dordrecht (P.W.L.), Aliwal (P.W.L.), and Stormberg (P.W.L. and 8, p. 83).

From Albert (A., C. 48 to 64) came a round-lipped pot with slip, 4 mm. thick, closely worked in deeply impressed columns of horizontal lines, from base up. At Smithfield also was found (S.A.M., 798) a sherd, black, of Bush quality, with incised line pattern of Bantu origin in horizontal scraped lines with suspended left diagonals. These show that during the fraternisation and intermarriage of Bantu and Bush in the isolated Heilbron area of the stone-building culture during its latter days the idea of potting and of ornamentation spread rapidly eastward and southward among the Bush peoples.

A lug of Type E was found at Kannemeyer (S.A.M., 1603) and another at Riverton (K.), and large imperforate mamilla at Smithfield (S.A.M., 1387).

Section X. South African Pottery: Coastal and Near-by Inland Areas.

Little Namaqualand.—Ovoid and conoid bases are usual (Types: text-fig. iii, Nos. 1, 2, 3, and 4), the base built upon the neck, and finished by an ammonite spiral where the finger was drawn out, and where it is frequently reinforced externally by a thick slip. A high degree of workmanship is shown. Necks are commonly vertical, neck-body technique usual; with lugs at shoulders. In the finest work the quartz admix is pounded small and is regularly distributed. The lip is usually overlapped, for 3 to 4 mm. Consolidated, and carefully trimmed (text-fig. vi, Types 4, 5, and 6). There is one specimen of lip Type 5, eversion without consolidation (H).

The Port Nolloth area produced fourteen lugs, Type A, with bridges ¾ inch to 1¼ inch wide; of more prominent bridges, becoming mamillated in appearance, only two specimens, and one doubtful stud form.

Only four externally applied over twig, Types B and C, were found. Patterns include 13, 14, 15, 19, and also, but only here, the square impression with central prick (*cf.* pattern 10); also short incised vertical lines, each with a dot beneath—thus!! Prick marks occur in vertical columns; and square impressions, applied singly, in horizontal rows, on one specimen only. Numerous combinations of patterns occur, square with cunieform, and Nos. 14 and 49. Certain compartmented patterns, 64 and 65, are suggestive of Bushman influence. The string marking described in Section V is the usual ornamentation on each neck.

Much search in the central and southern areas of Little Namaqualand produced little material, although the Kamiesberg is known to have been a great Nama Hottentot centre. The string-marked neck and right diagonals are in evidence, however (P.W.L.).

The use of pottery by the Hottentots had its effect inland, and occasional sherds of Hottentot type are found in places now far from water, the results of Bushman curiosity or of wet seasons which allowed greater range to the pastoral Hottentot.

Two lugs (Type A) have been found in Bushmanland, one showing red burnish; at Clanwilliam was found a small pot, ovoid, 6 inches high (S.A.M., 198), with narrow-bridged prominent lug (Type A), with a rough unburnished channel. Peringuey (18) illustrates a lugged pot from Ceres. A similar though not so prominent specimen comes from Lambert's Bay (S.A.M., 485). The Cape Flats have produced (all S.A.M. except one in Albany) eight such lugs, with non-prominent bridges, twig or finger-made channels, body thin to coarse, and one prominent lug bridge.

Port Nolloth area has produced one doubtful specimen of lug (Type B1); Clanwilliam a broad-bridged lug (S.A.M., 435) internally reinforced, the body of which has a large-sized quartz admix. The Cape area has produced another crude doubtful stud lug in which the stud appears to be of different clay.

Type E lugs have been found at Pella (S.A.M., 2578) and at Abiam, Gordonia (K.). Mamillae Types 1 and 2 occur in Bushmanland (S.A.M., 1232) and the large Type 4 at Kenhardt (A., C. 1089).

The Cape.—The Cape Peninsula and the area immediately surrounding Table Mountain was another oasis, thickly populated by Hottentots, and, as was the case also in Namaqualand, Bushmen inhabited the more inaccessible parts on its borders. The coarse quartz admixture is noticeable in this area, the finer wares of Namaqualand and the Eastern Cape are rare. Body shapes are ovoid and globular (text-fig. iii, Types 5 and 6). In the lug of one of these, the suspension cord has been preserved (S.A.M., 2513). The acutely shouldered conoid pot (text-fig. iii, No. 4) does not commonly appear farther to the east than the Cape Peninsula and its environs.

Lug Type A, Fish Hoek, has produced four.

Lug Types B and C have been found at Robberg (S.A.M., 2983) in a coarse pot, and at Fish Hoek one, and Simonstown one. One specimen of B comes from Somerset West.

A large imperforate mamilla, reinforced internally in manner similar to lug Type A, was found at Zeekoe Vlei.

The Cape to Mossel Bay.—The general characteristics of pottery in this area are:

A.—Early, thin-walled, 3 to 4 mm.; slightly sloping or vertical neck, regular string pattern; lips everted and consolidated (Type 6); neck-body technique; internally reinforced lugs, slight quartz admix; that is, Hottentot.

In this area Type A lugs have been found at Mossel Bay and Knysna areas, six (S.A.M., "Bain's 3 × 1128), one of the latter showing red burnish, the size of the reinforcement is 2 × 3 inches up to 3 × 4 inches. One doubtful specimen of B comes from Knysna.

B.—Gonaqua, the string marking combined with a chevron scrape over it occurs at Gamtoos River (S.A.M.). Nipples; 5-mm. walls; shouldered pots; appliqué work, spouts (Alb. Mus.).

C.—Late Gonaqua, typified by the Tzitzikamma pot (text-fig. iii, No. 7). Necks 6 cm. diameter, height 13·68 cm., diameter of belly 10·92 cm., circumference 34·38 cm., two lugs broad bridged, flat, wide apertures, angled channel, colour burnished. Occurs also at Slang River; Zuurberg; East London. The late Gonaqua type presents Bantu affinities in neck

and body thickness, colour burnish, necks free from string pattern, work heavy and coarse, quartz admix of large size.

Port Elizabeth-Keiskamma River (*Albany Area*).—Humewood, near Port Elizabeth, is built over extensive middens, and all river mouths to the eastward are fringed with the middens of "strand-loopers" who inhabited the district up to 1800.

The ovoid form persists, but only as a shoulderless open bowl (Rufanes River, A., text-fig. iv, No. 17). Here the apotheosis of the Hottentot potter's art took place and produced the Rufanes River pot (text-fig. iii, No. 8, and Plate V, B). Of forty-nine specimens from this area, thirty-two are fine types. Admixes generally are coarser in this area and are found in twenty-one specimens; in two the admix includes also a natural lateritic gravel. Among the coarser specimens a grass admix is found twice and shell once.

Lugs include Type A, three large and twenty-three small. Of Type B, three.

Of Type B, three suggest that the pot wall cracked across the bridge, during the process of piercing the well-made pot wall and projecting the bridge, which was then re-consolidated with slip. It is evident that the stud process of lug formation claimed by Peringuey is merely a repair method of infrequent occurrence.

Of repoussé mamillae, four; Type F, two; Type D, two. Large mamillae (Type 4) ornamented with concentric lines occur at Port Alfred and Kleinmonde on the Albany coast.

Large imperforate-pointed mamillae and internally reinforced as in lug Type A, have been found at Swartkop, Port Elizabeth, Gamtoos River, and Bushmans River cave.

Necks commonly show incised or scraped string ornamentation. Of lips, only one is overlapped to the inside (A., C. 1606). Other decorations include rows of prick marks, dissected herring-bone (pattern 39), band decorations of right diagonals between two sets of three horizontal lines (pattern 83), and compartmented patterns.

From Port Elizabeth (P.E.) comes a worm-like clay cylinder 25 mm. long applied to the external wall of a thin pot, and consolidated by pricking around its periphery. A similar appearance is produced (without appliqué) on the Dunbrody spouted pot (A., Plate IV, No. 5). Decorations include the long cuneiform, the left diagonal prick, repoussé work, appliqué work, incised right diagonals enclosed between horizontal lines, criss-cross enclosed between horizontal lines, and patterns 63 and 62; that is, there is a distinct tendency towards Bantu forms.

The better types, thinner, more highly ornamented, with well-made lugs, predominate.

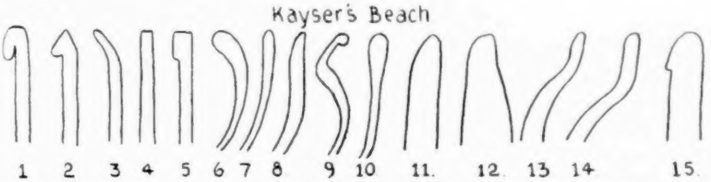
Kayser's Beach site, about thirty-two miles west of East London has, over a period of eight years, yielded much material. On Site I pottery is associated with bored stones, mill-stones, ground stones, palette fragments, *i.e.* it is a Wilton site. Site II is an indeterminate shell mound; and Site III is at the base of the dunes, where wind action has uncovered the surface. Site IV is a thin shell mound farther west. The pottery falls into certain definite groups.

A.—Recent Bantu, open bowls, probably shape 20 (text-fig. iv).

B.—Large globular pots, thick body, boldly flared neck, ornamented with deeply incised diagonals.

C.—Coarse thick body, hard burned, with much natural admixture, decorated with crude pattern 83. Body 7 to 12 mm., thick crackled.

D. and E.—On Site III—a degenerate and indeterminate type of late origin.



TEXT-FIG. xiii.

E.—Short-necked bowl, with repoussé vertical lugs, and crude band pattern 83 round the neck, a conjunction of Hottentot and early Bantu features (Plate V, No. 6), Site III.

F.—Vertical neck, square-trimmed lip, no overlap, with string pattern 84, or crossed lines, large quartz admix, colour burnished red, vertical neck which at base slopes gently into body, which is spouted, square lips, without overlap, columnar decoration on body, of two or three lines of impressions (bone end), from Site IV; that is, Gonaqua types, a mixture of Hottentot with later Bantu accretions, which hybridisation is supported physically by the East London skeletal material (39). Includes patterns 17*a*, 83; neck junction is at times consolidated with line of pricks.

G.—Pottery with overlapped lips lacking the delicacy of the Port Nolloth Hottentot specimens, though essentially similar in technique.

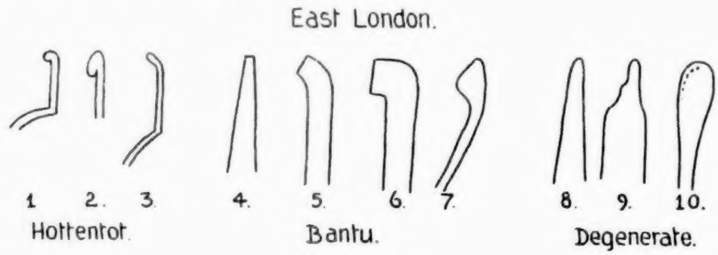
The variety of lips found on this small site is extraordinary (text-fig. xiii) and includes all varieties of overlapped lips, Nos. 1, 2, 5, 9, 10, and 15, varying from thin and delicate to thick and clumsy; from plain rounded to flared, Nos. 3, 6, and 7; or slightly shouldered tending to vertical neck, Nos. 13 and 14; or shouldered with rolled lip, No. 9, all of which tend towards Bantu forms. The plain tapered lips, Nos. 11 and 12, in coarse

material are separable on technique of clay preparation and coarseness of finish, and represent a degenerate phase. Lip or rim lug G 2 occurs once, in a small pot of Bantu appearance. (All specimens P.W.L.)

East London Area: Kidds Beach to Kei River.—The pottery (P.W.L.) is mostly from shell mounds and sand dunes, and falls into the following classes:—

A.—Recent, Bantu, black, large, neckless, found at higher levels than other types (text-fig. xiv, Nos. 4 to 7).

B.—Undecorated dun-coloured pottery, represented by a small drinking cup of Bantu size and shape, Buffalo Mouth shell mounds, West Bank; associated with thick, heavy flared, and internally bevelled colour-burnished rims of early Bantu or late Gonaqua types.



TEXT-FIG. xiv.

C.—Degenerate, ill-finished, coarse, black, untrimmed taper lips, externally applied lugs, usually without recognisable admix, and frequently containing lateritic material which is natural to local clays. Thirty-five specimens from Buffalo River, East Bank, and Blind River. Found at higher level in shell mounds than class F (text-fig. xiv, Nos. 8, 9, 10).

D.—Distinctly Bushman, bowls averaging 6 inches in diameter, hand raised from ill-prepared lump, thick based, taper lips, black body crudely finished and burned (Kei Road, P.W.L.).

E.—A few fragments of thick, well-made, deeply patterned pottery with broad scraped diagonals and three-line staggers, of early Bantu type (Kaysers Beach, B) (Shelley Beach; Buffalo River, West Bank, and Middledrift—P.W.L.)

F.—A few fragments of Gonaqua type, sloping or vertical necks, scrape and prick at neck-body junction, repoussé mamilla, patterns 13, 20 (site: Buffalo River, East Bank). Lugs, Types B and C, five.

G.—A few fragments of Hottentot type, vertical neck (text-fig. xiv, Nos. 1, 2, 3) carefully trimmed, overlapped lip, and carefully executed string marking. Forty-four fragments with two Type A lugs (sites: Buffalo River, East Bank; Blind River; Nahooon; Kei Mouth). In all

classes ornamentation, other than 6 and 7, is less frequent. One repoussé mamilla Type 3 was found in the Buffalo River shell mounds at East London. Elongated lip lug, Type G, was found twice, one specimen having two perforations. They are found only on the Port Elizabeth-East London coast, and occur in a coarse, black-burned, late degenerate pottery with admix uncertain in quality or quantity, and therefore suggest strongly that they are Bush-Hottentot in origin of a late period. Type G2 was found once, and Type H once.

The Transkei.—On an open site at Nghdla, between the river of that name and the Jujuga River, settlements from Middle to Late Stone Ages occur (41). The pottery is classified as follows:—

A.—Plain, crudely finished, taper lips, neckless, pots of Pondo type, the pottery of the Bantu tribes who, according to local tradition, *circa* 1860, congregated on the coast for shell-fish during a period of distress. A few square lips are criss-crossed.

B.—Flared sloping neck, counter triangles filled with alternating right and left diagonals 87 and true herring-bone, deeply incised (Kayser's Beach, B).

C.—Well burned, dun, decorated with a band of horizontal lines crossed by vertical lines; double bands of pattern 83.

D.—A few fragments only of Gonaqua types, of three different pots. The most northerly find of this type was at Port St. John's, a single fragment (A).

The Nghdhla site produced a vertically perforated mamilla, and one Type A lug.

Farther north, on the Pondoland coast, the excavation of Umgazana Cave (56) produced in its mud strata sherds of coarse black pottery containing grit. Forms represented are spherical with round or slightly flattened bases. The only ornamentation is round the rim and consists of single impressions. There are no lugs, but one sherd has a conical hole, bored after baking.

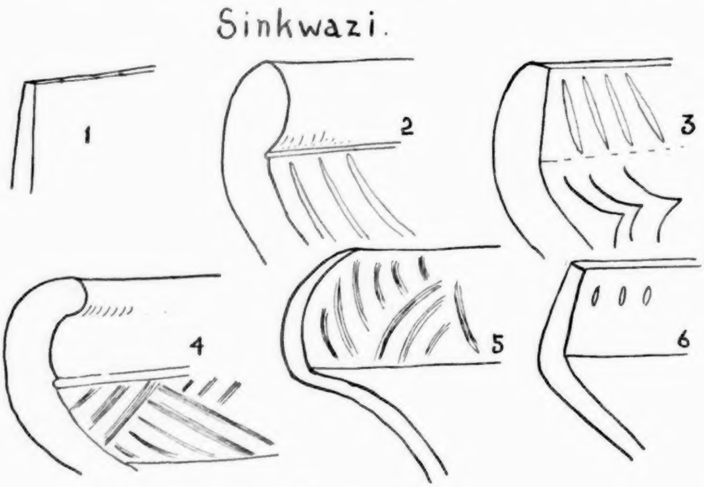
The Natal Coast.—Brien excavated and described (40) a small cave at Isipofu. Specimens of pottery found there were reported upon by us, without information regarding association, as being similar to degenerate Bantu. The sherds were found under a stratum of stones and 6 inches of soil in a recess, where there were remains of a hearth, and no other artefacts. No subsequent information tends to modify the ascription. At some depth beneath the sherd-bearing layer stone implements and human remains with boskopoid features were found.

An eared pot, claimed to be pre-Bantu (20), was found at Otto's Bluff. It was one of a pair, one being destroyed. The surviving pot has externally applied lugs of Type D. Its base is rounded, and the mouth slightly

contracted, lip is rounded (D). That it is "pre-Bantu" is insisted upon repeatedly, though no information is given regarding the reasons for that ascription. Farther north, at St. Lucia Bay (58), in a shell mound excavated to a depth of 4 feet, plain spherical pots with "simple thickened rims," entirely without decoration, and one fragment with a pierced mammiform projection or lug were found. The lug is not described in detail.

At Richards Bay (58) pottery similar to that at St. Lucia Bay was found.

The Sinkwazi shell midden site (57) was discovered in 1922, and it



TEXT-FIG. XV.

contained pots of varying sizes (D) up to 20 inches in diameter, with incised decorations around shoulders, necks, and rims, in herring-bone, double bands of herring-bone, criss-cross, suspended triangles outlined in parallel lines filled with incisions at right angles, and the triangle filled with right diagonals on the one side and left on the other. Much of the neck decoration is on raised bands. Similar pottery was found on the site of old iron workings in the Tugela River valley (57). It is compared by the writers with pottery from Maund ruins illustrated by Caton-Thompson (28) in pl. xvii, fig. 2, Nos. 1 to 3. The latter are in a black-burnished ware "B2." If attention is given to detail, it is seen that there are considerable differences. The Sinkwazi pottery is unburnished, and though well made is very thick. The incised ornamentation is exceptionally deep, and raises a flap rather than a burr, and the incisions are widely

spaced. The flared necks are well bevelled internally. With these combined characteristics it is easily separated from any other pottery.

Natal coastal pottery has been studied in detail by Schofield (55), who, in an important regional survey, classified his material into four periods:—

1. Pre-Bantu, which is an uncertainty. Certain pottery, N.C. 1, Schofield tentatively ascribes to this class.

2. Metal-working period, N.C. 2, dated 1550 to 1650. To this period and class Schofield ascribes the Umgazana pottery, which he describes as possessing both Hottentot and Bantu characters. It was found at depth in Durban North. It is usually made from a grey or blackish clay, burned to a light buff at the surface, which is sometimes "burnished to a brown." It is soft in texture. Pottery may be plain, or decorated with rough bold incisions, bands of triangles alternately plain and hatched with lines of comb impressions. One rim is grooved, moulded decoration in relief occurs, pot forms include platters, globular pots, shouldered pots, small drinking bowls, 6 inches across the mouth and 9 inches deep.

3. Metal-smelting period, N.C. 3. 1650 until dispersed about 1820. Closely associated with metal smelting. It is usually coarse and gritty, in colour varies from black to red, and has in its body fragments of incorporated potsherd. It is the pottery of Sinkwazi and the Tugela River valley, described above. Schofield describes the decoration as bands of herring-bone below boldly flared necks, counter-hatched triangles, and the principal types of form he notices were globular pots and drinking bowls (text-fig. xiv).

4. N.C. 4. Found only on the Karridene site. It is similar to modern Natal pottery and has a resemblance to Matabele pottery in the Potgeitersrust area, with which people the modern Natal natives are distantly connected.

Under the heading of Miscellaneous is described a spout from the Tinley Manor dune. The pot to which it belonged was roughed out in a fairly coarse clay and finished with a finer material or slip, the junction between the two being clearly visible. We are quoted (23) as appearing to ascribe the use of "such slip" to the Bushman. So far we have not described a slip of this description. The spout is stated to be paralleled by examples from Mapungubwe. From this same dune come four pot pipe bowls. Mapungubwe produced no pipes.

Of the third type, a quantity has been found at Umhlanga (P.W.L. and A., C. 1082; and D.) and Umhloti (P.W.L.).

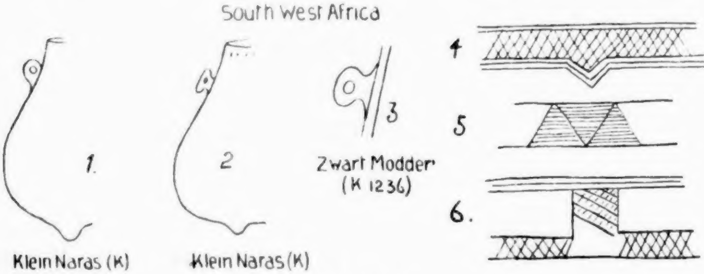
The Hottentot-Gonaqua types are, in this area, absent. Apart from the perforated mamillae described above, only one other specimen has been recorded from this area (18, p. 126) of a very coarse body.

It is noticeable that in Schofield's earlier types comb patterns and

comb-patterned lips occur, and that platter types are present. Nicking of the lip occurs both in his N.C. 2 and N.C. 3. It is ascribed by that investigator to Sotho influence, to which also he ascribes the comb patterns. The similarity between this ware and that of the Bahurutsi is stressed by him, and we concur. Both N.C. 2 and 3 appear to be of some antiquity, though not so early as Early African. The Sinkwazi type, N.C. 3, Schofield attributes to the Lala, a people of Makaranga or Shona stock. The similarity between the boldly flared necks and scraped patterns of this class and certain pottery at Inyanga (text-fig. xvi, Nos. 2 and 3) and the possible relationship between them is mentioned by that investigator.

Section XI. South-West Africa.

Dr. Fourie, A.M.O.H., Union, collected forty-six pots, and there are odd specimens in S.A.M. and W.W.R. The majority are of recent



Text-fig. xvi.

manufacture. They have been raised from the lump, thick based, thinning to lip, which is irregular with externally applied mamillae of small size; forms include bowls and flat platters, so that the utensil assemblage is Bantu in facies; and long-necked pots, vase-shaped (text-fig. iv, Nos. 18 and 19), a type which is found only in the northern part of Little Namaqualand, north and east into the Kalahari, and the Lake Ngami area among the Masarwa Bushmen, who have much in common with the Bantu. These latter pots vary from 9 to 14 inches in height, inclining to the smaller size, are built up in rolls from a somewhat flat base. Ornamentation shows compartmented Bushman characteristics combined with Bantu, consisting of patterns 28 combined with 83, triangles filled with diagonals or with horizontal lines, patterns 57, 83, 63, 84, 90, the last being a reproduction of the gourd suspension-net tassel.

The Topnaar Hottentots made pots in their country up to comparatively recently, which are degenerate Hottentot types, ovoid, with externally

applied lugs (the Kuiseb pot, Dr. Fourie; S.A.M. 1231, and W.W.R.E.M.). There is so far no record of the better and earlier Hottentot types of pottery in South-West Africa.

Text-fig. xv illustrates diagrammatically three specimens (Nos. 1, 2, 3) of this type, at (K.).

The only authentic stud lug recorded is a South-West African specimen from Zwart Modder River (K., 1236), in which a disc lug, 1 inch broad, is externally applied to a perforated pot wall and plugged into position.

A unique lug from South-West Africa (S.A.M., 1231) is externally and horizontally applied without any bulging inward of the body, and is perforated vertically, a mixture of Types D and F.

In S.A.M. is a specimen of coarse black ware from Walfish Bay in which cracks have been repaired with thin, flat, copper stitches passed through bored holes and covered with resin.

Section XII. Pottery found in Bushman Caves.

Bushman potting technique is invariably raising from the lump over hand and never reached a high level, though he attempted florid ornamentation. The Kalahari Bushmen made rough earthenware pots, more frequently to preserve materials in than for cooking purposes. They made hide pots for holding liquids (K., and Plate XIII, No. 1). The Bushman cooking-pot was small, of capacity one to two quarts, used for cooking meat and making a kind of porridge of grass seeds (42, p. 58).

The Bushmen of South-West Africa on the north banks of the Orange River use clay pots bartered from the neighbouring Bantu (1). Dunn (8) distinguished between Hottentot and Bushman pottery by texture. The former was well baked, hard, of good shape and size; the latter was soft, crumbly, without lugs. From these descriptions one would expect "Bushman" caves, *i.e.* Late Stone and Bone Age deposits, to produce only crude pottery. But careful inspection of shelter finds discloses many curious features.

Finds in shelters are rarely of pottery, usually of sherds and rarely in sufficiency to build up any portion of a pot. They are odd sherds, with their edges and surfaces encrusted with ash. Fragments came from the surface layers of the Wilton cave (A.). In the few instances in which whole pots have been found they present strong affinities with the Bantu, *e.g.* in caves at Zastron there are attempts at burnish, broad incisions, and mamillation, the last probably being an introduced piece. At Cathkin Peak (W.W.R.M.S., 43) four pots are of Bush origin, vertical-sided and slightly burnished. A pot from a Kei River cave deposited in a Late Transkeian Stone Age culture and containing a handful of human hair

is of Bushman shape and texture, but it also is water-burnished and has the lip nicked in imitation of a Bantu pot, and has a linear pattern of circular depressions, which also is reminiscent of Bantu method (Plate XIV, P.W.L.). Quite outside this class is the small pot, 1½ inch by ¾ inch, from Craigieburn (A.). Other pots without Bantu affinity have been found at Izingolweni and Paddock (Natal, text-fig. iv, Nos. 12 and 13; Kei Road, P.W.L.). That pot from Macomo's Hoek, near Balfour, with an externally applied lug and containing a skull of Bush type (A.), is undoubtedly the result of contact between Bushmen and the Free State building culture, where infant pot burial was common (Plate XIV, No. 15). There is usually a tendency to flattish base, as in the specimen S.A.M., 2578, from Pella, and those described above.

Finds of lugs in shelters are usually odd. The Tzitzikamma pot is complete (P.E.) and has broad-bridged Type A lugs. Others have been found at Pluto's Vale (A., C. 1089), Howiesons Poort (A.), Le Cateau (A.), all in the Grahamstown area; and others at Oudtshoorn (K.) with twisted fibres still in position in the tunnel. Of Type D, one was found in the Wilton cave and another in Hell Poort cave, both in the Grahamstown area.

Inland sites have produced the A type lug at Tarkastad (19), Graaf Reinet (8), Middleburg (S.A.M., 693), Kuabas, Namaqualand (S.A.M.), Aberdeen (8), Sutherland (S.A.M., 795), the Stormberg area produced thirty-seven specimens (A.C., 50–87), Ladysmith (18), Beaufort West (K., 1022), Koffiefontein, O.F.S. (K. and W.W.R.M.S.), South-West Africa (K., 1236).

The occurrence of potsherds in the mid-strata of the Umgazana cave is important, and it is to be deplored that the pottery was not illustrated (56).

The Ezolo cave in the Transkei produced: three fragments of string-marked, somewhat coarse Hottentot pottery, probably from three different pots: three fragments of plain taper lips of three different pots, passably well made, hard, two of which might be classed as Bantu, and one which is not Bantu but shows Bantu influence; four fragments of dun-grey water burnish certainly of Bantu origin. Several fragments of black, well-made, well-burnished pottery, certainly Bantu; two fragments of coarse, thick, well-finished, well-burned pottery, certainly Bantu; one fragment of neck-body junction found on the talus, well burnished, neck ornamented with right diagonals, upon a basal trimming line, probably Late Gonaqua; two mamillae, repoussé, surrounded by prick marks, Early Gonaqua.

Surely no one would have the temerity to suggest that the Late Stone Age men who inhabited this cave made all these varieties of pot, the whole mass of which is insufficient to form a pint milk bowl.

The Ngcisininde Valley cave in the Transkei (P.W.L.) gave stratigraphical evidence that Bantu pottery of Sinkwazi type, and vertical-lugged Bantu pottery, which appears to be the prototype of the Tarka-Queenstown type, followed the Gonaqua in this area.

The contents of caves give a serious warning against dogmatisation on cultural affinity, or culture assemblage as opposed to accidental association, due to importation through theft, barter, or curiosity. Implements from cave deposits may represent coherent assemblages: Pottery is an agglomeration of sherds from various sources—Bantu, Hottentot, Gonaqua, Bushman; and of all these, Bushman is the rarest. The great variety is in itself a strong argument against the practitioners of the associated Stone Age culture having possessed any highly developed faculty for potting. The evidence of the coastal mounds also is against the existence of much potting among Bushmen, except during later years.

Section XIII. Classification of South African Native Ceramics.

Frobenius (27) classifies all African pottery under two heads:—

One: with lines filigreed into the plain, natural colour of the vessel, in particular on the shoulder, and grouped in triangles (*i.e.* incised ornamentation).

And *Two*: a many-coloured ware showing black patterns in interrupted and curved ribbons on a red background.

He states further that vessels of both styles are found to this day in the hands of natives, especially in the north, but that the "red-and-white variety" is far rarer. To this latter rare class Frobenius allocates the animal vase found by Harry Posselt *circa* 1890 at Zimbabwe, of which a third specimen was identified recently as old Muonve. He states further that a female potter in the Wedza district makes similar animal pots to this day.

Caton-Thompson classified Rhodesian pottery into six types (28):

A (28, pls. xviii and lxix).—Varies from coarse red-brown to dark grey. Body gritty with quartz (natural?); decorated with moulded lips and with diagonal lines of square comb impressions on the lip or neck.

B.—A finer textured ware. Black-burnished but undecorated. (Caton-Thompson describes the burnish as a slip, which it certainly is not.)

B1.—A "black-surfaced" ware, decorated with moulded or raised ribs. Rare.

B2.—A black-burnished ware with wet incised lines. Claimed to belong to later deposits.

C.—A brown-burnished ware, thicker and coarser than B. A contemporary fabric.

D.—"Polychrome" burnished ware in red and black. The common decoration being arranged in geometrical patterns, separated by incised lines. Found sparingly in later deposits at Zimbabwe. Common at Khami.

It is now possible to go much further than this, and to divide South African ceramic development into three main periods—Early African or Pre-Zimbabwe; Middle African, including the Zimbabwe Period and culture; and Late African.

Early African (i.e. *Pre-Zimbabwe*) *Eastern Types.*

E.A. Type I.—Associated with early stone (boulder) enclosure building, and with iron working. Widespread, found at Niekerk in early deposits, Salisbury, C., and sub-Zimbabwe, of probable age tenth to fifteenth century; in the last-named place associated with imported glass beads of Class I (22). Characteristics: coarse red-brown to dark grey friable (age?) with quartz admix (28, pl. lxix) and decorated with diagonal or other arrangements of shallow square or round impressions in comb, incised staggers, suspended or supported triangles formed of or filled in with dots, and bangle impression; the lips may be plain or decorated, squared or rounded, and one is everted. The bangle pattern is distinctive of the north-eastern region, is present also at Mumbwa in Northern Rhodesia, and pottery of this period was found on the shores of Lake Nyassa by Mr. Midgely (A., C. 1148) with everted lip, three-line right staggers, combined with vertical lines, and bangle impression. Pottery excavated by Miss Earthy in the Sofala district also falls into this class.

E.A. Type II.—Localities: Salisbury, B. and A. (34); Niekerk open deposits; Lake Nyassa (A., C. 1147). Characteristics: full range of "Bantu" type earthenware utensils; large pots, medium pots, water pots, food platters; body has a tentative black graphite burnish; internal black burnish, bangle pattern, and comb impressions combined with incised lines. This was the period of development of the roll lip.

E.A. Type III.—There is a distinctive cave-dwelling association with a distinctive class of Early African pottery which appears to follow immediately upon the Rhodesian Wilton culture and is associated with iron working. So far, recognised only in the Southern Rhodesian caves at Madiliyangwa, Whitewater, Gulubahwe, Bambata, Gokomere. Characteristics: tall vertical necks, with horizontal scraped "string" marks, or ringed round in prick and drag, well executed and strikingly similar to the Hottentot designs. Body is well made, greyish to dark grey; or as at Bambata, black or red, where is included a spout (Plate X, No. 17).

The Hottentot "migration" probably took place during this period

of Type III. Further study of early sites in South-West Africa is necessary, but this type of Early African does not appear to have spread westward or southward. It is not, however, advisable to consider Hottentot pottery and its offshoot Bushman, under this type.

Early African Western Types.

In this area, represented by the Bechuanaland sites, the imported glass bead and the pot whorl is not associated with pottery, though the ostrich eggshell bead is. The imported bead period in the east may have been synchronous with the Bechuanaland Early African period in its earlier phases, but so far there is no evidence to suggest that this is the case. The finding of beads of Class II (22) on the surface at Serowe suggests an early date for the close of the occupation of this and similar sites. Excavation at Dithebyane and Serowe gave a graded ceramic series. The characteristic feature of the Western type is the development of contrasted monochrome and the extremely carefully executed and symmetrical patterns. That black burnish which occurs is dull, not glossy.

E.A. Type IV.—Lower Western (Plate X). Localities Dithebyane, Maokagane, Serowe.

Square comb impressions, spineless herring-bone, and three-line staggers, between carefully incised bands, all patterns carefully executed, lip types broad, oval on section, moulded applied lips. Contrasted monochrome; patterns in brown and red. Bichrome black and red. Combination of incisions to produce raised squares and oblongs (pattern 79). Quartz admix.

E.A. Type V.—Middle Western. Localities: Dithebyane, D; Maokagane, A and B; Modaepae, A; the execution of patterns degenerates somewhat; incisions become wider, shallower, and show less symmetrical and careful finish, only a few sherds show a slight burnish, lips are thick and heavy, patterns include comb right diagonals and staggers; the type is associated with ostrich eggshell beads.

E.A. Type VI.—Upper Western. Localities: Dithebyane, C; Modaepae. Of early texture but without comb patterns, lips squared; parallel incision with decoration between forming bands, the common type is 80; criss-cross made by light cross incisions. Thickness is variable with size of pot; finish in all cases extraordinarily fine. Contrasted monochrome also occurs.

The predilection of the east for graphite burnish, and of the west for contrasted red monochrome is noticeable. The few contrasted monochrome sherds found at Zimbabwe are a contact from the west.

Pottery of the Middle African, or Zimbabwe Period.

The type list must not be read as an evolutional series. It is an attempt to classify into reasonably watertight classes which may or may not be contemporary. The matter of period is considered separately below.

The eastern black burnish development of the Zimbabwe period is associated with early Zimbabwe type walling and gold working. The fine black burnished (Caton-Thompson's B), and plain water-burnished finely mottled (Caton-Thompson's C) are associated, and have been separately classified (28) when they need sub-classification only. On all sites there is a wide variation in ceramic finish, and a wide variation in ornamentation from simple to complex. There are undoubtedly two domestic qualities, and even characteristics separating the possessions of the sexes, as well as of social classes, through all periods.

When the Zimbabwe culture reached its southern limits in the Bechuanaland Protectorate, the pottery then made was mostly left unburnished, though a proportion was black burnished. This finish, it has been shown, is characteristic of the north-east; the people of the Zimbabwe culture, the black burnishers, migrated south and east, meeting the colour workers, and the two methods then were combined. There appears to be a gap between the occupation of Bechuanaland by the Early African culture and the appearance of the later Bantu cultures of the Zimbabwe period in that area.

In the west central area of the Middle African culture a strong polychrome development took place, represented at its best in the area Dhlo-Dhlo, with a slight outlier at Zimbabwe and later effects at Mapungubwe.

M.A. Type VII, A.—Eastern area of Rhodesia only. Localities: Zimbabwe, Chibvumani, Chiwona. Found mixed with A, suggesting mixed influence or a southerly migrating people later than the makers of Type II.

Chiwona is considered by Caton-Thompson (28, p. 128) to be later than Zimbabwe. Patterns occur there which are not found at the latter place, merely another indication of local fashion or isolated development. Lips are well flared, necks vertical, glossy black burnish. Bands of applied clay occur at the neck-body junction (28, pl. xxi, 1) and may be ornamented or unornamented, and patterns tend to become complex. Three fragments of this sub-type were found at Zimbabwe, in the Acropolis midden, with the band decorated with left and right diagonals alternating in the spaces of a line dancetté.

M.A. Type VII, B.—Coarser pottery, neckless, heavy rolled lip, No. 28.

M.A. Type VIII.—Late Middle African, Southern Rhodesia. (Still

free from European influence.) Localities: Matendere, Dhlo-Dhlo. Characteristics: black burnish scarce; most sherds are fire mottled; carelessly incised, with a large quartz admix; flared neck and globular body are similar to Chiwona post-building occupation (text-fig. vi, No. 6). At Dhlo-Dhlo the body finish is better and vertical necks occur.

This period is dated at about 1700 on imported china (28), there is every probability that the period is half a century or more later. Pottery whorls are present and form an important dating factor.

M.A. Type IX.—The bichrome development in the west of Southern Rhodesia. Localities: Khami, Dhlo-Dhlo, Lotsani. Bichrome ware and contrasted monochrome in its highest development is essentially a western type. It belongs in its middle days to the Zimbabwe period. Only a few fragments were found at Zimbabwe; a few in a low rock shelter at Chiwona, which suggests it is later than those ruins; and a few on the surface at Gombe mountain (28). It is the typical pottery of Dhlo-Dhlo, and was found also by the writer at Lotsani. It occurs in the Northern Transvaal and the Free State. It developed from the contrasted monochrome work of the pre-Zimbabwe type enclosure builders in Bechuanaland.

Most of the Dhlo-Dhlo pottery is not true polychrome, *i.e.* burnish of more than one colour, but consists of colour-burnished bands contrasted with non-colour burnished surfaces. Hall and Neale (30, p. 154), who knew nothing of its distribution or origin, hailed this type as an undoubted Phoenician affinity. Had it been an eastern type their history could have been less absurd. It is generally attributed to the Baroswi tribe (28, 26).

The Zimbabwe Class D of Caton-Thompson was classified solely according to its superficial character, but it is characteristic of an area as well as a period, and the finding of a few pieces at Zimbabwe and in the Chiwona shelter is an indication of the border-line overlap. Its characters include incised patterns without delimiting outlines; colour-burnished patterns with incised geometrical outlines; incised wet or dry, *i.e.* wet with various instruments, and after firing by sharp metal instruments alone. Patterns are bold and surfaces vary from smoothly burnished to rough.

The Dhlo-Dhlo pottery is less smoothly burnished and includes more contrasted monochrome than bichrome, and the colour is contrasted against a matt surface. Red monochrome is contrasted against pot-burned brown. Pottery whorls are found at Dhlo-Dhlo (26).

M.A. Type X.—Late; Bechuanaland, colour burnished, contrasted monochromes. Localities: Maokagane, D, Lotsani, Modaepae (*b*). Prick-and-drag patterns common, goblets used.

Is directly connected with the prick-and-drag patterns and coloured triangles so common on pottery of the late Rhodesian phases at Salisbury and Echo.

M.A. Type XI.—Black-ribbed ware (28, p. 51); five fragments were found in different sites at Zimbabwe (high up). It is undoubtedly a separate type. The Que Que pot, found in an ancient working, is of this type, though it is of unburnished brown ware (26, pl. liii). It is this pottery that Miss Caton-Thompson considers establishes a connection between miners and builders (28, p. 9), for which conclusion there is little evidence; though the Que Que pot burial may have taken place during the mining period, the people of this pottery are not the early Zimbabwe period people.

This ribbed pottery occurs in certain almost invariable positions to the exclusion of the plain ware. At Inyanga Needle kopje, on the hut platform at the summit. At Zimbabwe it was found on the Acropolis between 8–17 feet in depth (28, p. 77), where it is later than Type VII, and is ornamented.

Matendere pottery should fall into this class.

The technique of the ribbed variety of this type of ware probably developed from the ribbed necks of Type VII, within which, however, bandied bodies have not been found as yet. Another possible affinity is with the banded celadon ware imported during earlier periods, and we believe that this pottery may be imitative of the characters of the imported porcelain, *i.e.* that this type shows definite accretion of outside ideas. On the other hand, the arrangement of the bands is essentially that of the grass and leather carrying thongs of the west.

M.A. Type XII.—Is probably the household ware or the provincial ware of the preceding class. The ware is well burned, thick, at times crackled, with quartz admix, thick lips, with only a slight tendency to vertical necks, and generally is comparable with the latest pottery on other sites, *e.g.* Heilbron. Lips mostly everted, necks curved, *i.e.* with a marked tendency towards the modern types.

The black-ribbed ware does not occur alone—associated with it is material plain and unornamented. Such ribbed ware, but without the black burnish, is still made by the Bahurutsi of the Transvaal.

The conclusion that the pottery of the Inyanga pits belongs to this type and period is based on the examination of specimens, their similarity, and the exclusion at Niekerk ruins of Early African pottery from connection with the building remains there, and the presence of the triangular stamp impression (44) which occurs at Mumbwa, Niekerk, and also at Machadodorp on surface exposures.

M.A. Type XIII.—Northern Transvaal. While the Rhodesian stone-building culture degenerated, and the Heilbron colony became isolated and bushmanised (24), in the Northern Transvaal the relics of the culture persisted, especially at Mapungubwe, fifty miles west of Messina, where

iron and gold workers, artistic potters, and wall builders persisted at a date probably later than the bichrome Type IX, which is represented at various other smaller sites in that neighbourhood and also in the Free State. This period is probably synchronous with that of Types XI, XII, and XIX. Distinctive local developments are found. The prick and drag of Type XVIII is found, which still survives among the modern Bavenda. Black burnish attains a high degree of finish, and so does ornamentation upon plain burnished pottery. The use of the stagger, the incised raised square and oblong (which reaches the dignity of a panel) shows affinity with the earlier Bechuanaland patterns (text-fig. iii, No. 79) described above, belonging to the pre-glass-bead period. Doubtless Mapungubwe represents the next higher stage in development, and points towards a more or less isolated or tribal development. The site as a whole, however, is undoubtedly a late one, though not so late as Chwenyane, and it is, therefore, particularly important to notice the persistence of methods of potting ornamentation on stone-building sites. This site, more than any other, establishes that connection between kopje dwellers, potters, gold workers, postulated in the description of Bechuanaland and Rhodesian sites. The relationship between chiefs and high places is also established, for only chiefs were buried as described by the excavators (45, and other reports in the press). Bar lips occur and the goblet form of drinking cup, similar to the calabash still used by the Bahurutsi.

M.A. Type XIV: Bichrome of Southern Transvaal.—Machadodorp, though an important area for ruins, which are found in superposition, is otherwise wholly lacking in stratigraphical evidence, it is seemingly a glass beadless area of metal workers and agriculturalists. The sherds recovered are distinctly separable into three classes:

A.—Red monochrome burnish with dry incised patterns. Bichrome red and black, with incised meander separating, and short vertical neck, ornamented with well-spaced left diagonals, a type of ornamentation that has not been found elsewhere, lips rounded, usually not tapered (one tapered), necks flared, vertical, sloping; one sherd whorl, referable to type X.

B.—Deeper, cruder incisions of similar type.

C.—Late, intrusive coarse pottery with splayed ring base, Type XIX, B.

The colour-burnished pottery of the Northern Transvaal, Orange Free State, and Southern Transvaal is connected with Bahurutsi and modern Basuto work, and its distribution probably defines the line of their migration. The similarity in pattern of certain Limpopo area and Orange Free State specimens with modern Basuto is striking.

M.A. Type XV.—Free State area. The Heilbron deposits (24) show at least three ceramic periods, all seemingly free from association with

imported glass beads, suggesting that the earlier occupations preceded European coastal commerce or that the community was isolated for a period after settlement.

A.—Pottery with applied bands, black body, dull water-burnished, the bands finger-moulded, found only on outlying middens of the early occupation at Willowglen. Type XX.

B.—Fine monochrome, found in midden of middle period contracted occupation, similar to early Bahurutsi products at Chwenyane: Type XIX, A.

C.—Casual finds on the middens of small settlements, with no stratigraphical guide, include comb impression patterns similar to those of Chwenyane, to which period they probably belong, *i.e.* Type XIX, A.

D.—Contrasted monochromes on a matt base which are similar in general appearance to those of Khami, but it is at present impossible to state whether they belong to phase C or to an earlier phase. We incline to the former conclusion.

The Late African Period.

L.A. Type XVI.—Heilbron, F, latest occupation, bushmanised Bantu, associated with later stone-building culture. A separate and localised development in which are two distinct phases:

A.—Well-made pottery of fair shape, modern Bantu forms, much slip and extensive patterning of pot surface (Plate XV, Nos. 5–9). From this, Type XXV of the country to the east developed.

B.—Poorly made pottery of poor form, tendency to flattened base, plain taper lips and little or no patterning.

L.A. Type XVII, A.—Early Bantu, east coast. Kaysers Beach, B, East London, Middledrift, Transkei, B. The Sinkwazi type which presents certain definite features which show affinities with the pottery of certain Rhodesian ruins. This ware is not colour-burnished, is dun or yellow, with well-flared neck, globular body, and the neck-shoulder area is sometimes ornamented in chevron patterns boldly performed with a broad scraping motion. The northern wares with which affinities are shown are Mchuchu, A, and Niekerk, A.

The type is associated with iron smelting and occasionally the pattern is on a raised band (text-fig. vi, No. 4). This is uncommon, but it occurs also at Sinkwazi, Umhloti, and Nghdhla farther south. Schofield decided (20) that it belonged to an early period. It doubtless represents an early Bantu migration coastwise, later than the Zimbabwe phase which produced Type VII, and it preceded probably the Gonaqua phase Type XXIII, and certainly preceded the migrations of the Kaffir wars, *i.e. circa* 1750–1800.

The similarity in method of ornamentation with the pottery of Mapungubwe, Chiwona, and Chibvumani is striking.

L.A. Type XVII, B.—A sub-class of this type has ornamentation, wide but deep, in which pattern 57 is a favourite. This has been found in fragments at Middledrift, near East London (48), associated with Late Stone Age implements in Cave 11, Transkei. This is probably the result of the Bantu invasion of the south-east coast which took place historically, *circa* 1750, and the extent of which is the extent also of the distribution of this type. It forms a link between north and south, overwhelms the early Cape types, and probably is responsible for the greater Bantu affinities of the late Gonaqua Type XXI. The Rarabe raids of 1750 petered out, the Bantu retreated to the coastal areas of the Transkei, finally to return and permanently occupy the lands to the south, *circa* 1840.

L.A. Type XVIII, A.—Late Rhodesian bichrome. Localities: Echo, Salisbury, A.

Those at Echo were locally considered to be pre-occupational, *i.e.* before A.D. 1890, but are unassociated with the stone-building culture. They are similar to four pots from Niekerk ruins' deposits (26, pl. xi), there is a direct connection between the two; the colour burnishing shows, however, that they are a later product, the pattern of prick and drag in comb around the neck indicates the survival of method in ornamentation, and similar is still found among the Bavenda of the Northern Transvaal.

L.A. Type XVIII, B.—Is a ware in monochrome, otherwise similar to Type XVIII, A. It is the pottery of the second Mchuchu post-building and post-desertion occupation.

L.A. Type XIX, A.—Finely burnished red pottery with flared necks and nicked lips found at Chwenyane, Lobatsi, Heilbron, B, which the Chwenyane deposits showed was contemporary, with suspended triangles, outlines in square-comb impressions and filled with a colour contrasting with that of pot wall. Superficially this type is similar to Type XVIII, but that type is distinguished by the use of the prick-and-drag technique by comb, without other comb impressions.

B.—Pot bases of varying breadth, found at Machadodorp, Airlie, Chwenyane, and conical and narrow splayed pot-cover knobs, found at Heilbron (surface), Machadodorp, Buispoort (46), and Chwenyane. The latter were originally believed to belong to narrow based pots, and though these may occur, the majority of the smaller cones and splayed knobs undoubtedly belong to pot covers. Bases show wear, knobs do not. They belong to the dated Chwenyane period 1823–36.

L.A. Type XX.—Degenerate coastal Bantu. The archaeology of the Nghdhla open sites was discussed in S.A.J.S., 1935 (41). It showed that there was no connection between pottery and stone implements other than

that of propinquity. Certain mounds were purely Bantu, which is corroborated by local tradition which states that during great droughts of the mid and early nineteenth century, the Bantu tribes for long existed on shellfish along this coast. The pottery of this series of shell mounds is classified as follows:—

A.—Gonaqua, small quantity only, to inland side of central mound.

B.—Bantu (?), Sinkwazi type, of crude finish, Type XVII, A.

C.—Bantu, well burned, flared lips, curved necks, decoration well finished, double-raised band of pattern, a few lips of type herring-bone (Type XXV).

D.—Crude, ill finished, taper lips.

Types C and D are probably contemporary. Degenerate ill-finished pottery of Bantu type is found at various places on the coast from Algoa Bay to the Natal border, and probably belongs to the drought period referred to above.

L.A. Type XXI.—Modern Bantu. This type was dealt with in S.A.J.S. (23). Bavenda pottery is closely associated with Types XVIII and XIII. The Basuto people settled in their present area, *circa* 1750 (49). There is considerable similarity between the finger work on the lip of sherds from Lotsani I and on old Basuto pots from Masite (A). There is, further, a considerable polychrome development and utilisation of modern European shapes, such as handled jugs, cups, and saucers, developed from their parents the Bahurutsi. The chalice type (Plate XVII, No. 15) with splayed base is original, is the male cup, and is connected with the splay bases of XIX, A and B.

The south-eastern Bantu, Xosa, and Pondo make very little pottery to-day, except north of the Kei River, which is comparable with present-day types from Lobatsi and Machadodorp. The eastern Zulu-Xosa-speaking people favour the globular pot, a non-shouldered pot. The western Sechuana-speaking people favour the globular type of body, with vertical or angular neck, where, however, the intrusive Baghatla favour the two-piece technique, producing various degrees of angled neck.

E.A. Type XXII.—The better material of Hottentot type occurs round the eastern and western edges of the Cape Province coast. Van Riebeck in 1654 (47) had found some minerals, and desiring to smelt them sent the catechist to the Saldanha Hottentots at Saldanha Bay to obtain some pots.

At East London, efforts to obtain sherds, *in situ*, in the middens were successful. Separated by layers of wind-blown sand, the following series was obtained:—

Above.—Many coarse, thick bases, hand raised from lump sherds, and few thin distinctive Hottentot sherds.

Below.—Five Hottentot sherds, with usual scraped string-patterned neck and consolidated everted lip.

The pottery of this class does not appear to present the variety in shape and size that the Bantu series does. They were used mainly for storage and were egg-shaped.

Pot tops for sewing on to leather bottles occur in Namaqualand and at Klein Karas, South-West Africa (Plate XIII, No. 2).

The thinness of wall, down to 4 mm., in large pots of several gallons capacity is distinctive. Impressed marks are common. The thinner the pottery, the finer the admix. Quartz admixture, prominent in Gonaqua and eastern Hottentot pottery, first becomes noticeable in Gonaqua, and eastern Hottentot pottery first becomes noticeable at the Cape (S.A.M., 780), Blaauwberg (S.A.M., 1123); coarser admix appears in this pottery at Kayser's Beach. The finest Bantu pot and the crudest Bushman usually show no visible admix. In South-West African specimens there is no coarse admix; in Namaqualand and Bushmanland many fine, only one coarse; at Mossel Bay, Albany, Kayser's Beach, quartz admix is at its coarsest height, and at East London, where finer Hottentot types are rare, it also appears. This is the area of Hottentot pottery.

Type A lug, the typical Hottentot artefact, occurs along the large inland rivers, rarely in South-West Africa, never to the north of the Vaal River and rarely to the north of the Nghdhla River in the Southern Transkei. This distribution relieves them from any direct connection with the Bantu, for fewer are found along the line of meeting. Perforated mamillae, and mamillae, occur more commonly along that line and in the Gonaqua area. Cylinders perforated vertically occur only within Bantu areas, where they are also found on carved wooden pots (Type F).

Lugs of Types A, B, and C are distinctively South African in distribution and in origin. In Egypt, where most prototypes of African design may be found, nothing of this type exists, though Type F is common, even in stone. The former are commonly found in shouldered pots of neck-body junction technique.

The lug is of indigenous origin and is closely connected with Bush and Bantu ideas of suspension and carrying, for which there are two methods, lugs on wooden and earthenware vessels used with cords, and cord-net suspenders for calabash and earthenware vessels. The Hottentot lug is probably a development from the early Bantu cylinder.

The scraped string-mark follows the distribution of the lug and occurs in Namaqualand, the Cape Province, and on the coast from the Orange River in the west to Port St. John's in the east, but is less frequently found from East London eastwards. Inland it occurs at Fraserburg (S.A.M., 1223), Sutherland (S.A.M., 295), Aberdeen (8), Middleburg (S.A.M., 693),

Prince Albert, Tarkastad, Graaff Reinet, Koffiefontein, and Riet River (W.W.R.M.S., 244). The small number of specimens from the Orange Free State is notable, and the majority occur south of the stone-building culture area. This points to a widespread Early Hottentot occupation, fanning out from the Free State mostly to east and west, with a later infiltration of Bantu ideas along that route of least resistance, now followed by the railway from the Free State to Port Elizabeth, which introduced a few fresh ideas and intensified certain older ones. Vertical necks disappeared, spouts disappeared, lugs persisted. Patterns include 1, 2, 3, 4, 5, 6, and 19.

The notable finds are the spouted pots. One was found at Kleinsee, Namaqualand (K., Plate XIII, No. 4), another at Sundays River (Plate XIII, No. 5), and others at Kayser's Beach (Plate XIII, No. 3), Tinley Manor, Natal, Mapungubwe, Bambata. Of these the first three sites are definitely pastoral Hottentot, the remainder equally certainly belong to the stone-building culture people and their offshoots.

This points to the origin of Hottentot pottery, and to the necessity for the accepted traditions of Hottentot migration being revised, because it appears to have radiated from the Free State, probably along the Great Rivers, to south-east and south-west, from the period of Type III. Of their history between these two phases and places, there is at present no suggestion. There is no ceramic evidence supporting the accepted theory of a Hottentot migration west to the coast and then north and south.

M.A. Type XXIII is that of the Tzitzikamma-Port Elizabeth-East London area with a slight extension to Cape Peninsula, and inland to and including Prince Alfred and Graaff Reinet, which covers the lands inhabited by the Gonaqua, who were in close contact with the Bantu. The characteristics of the type are the use of certain decorations, such as the drag and prick to the neck-body junction, and patterns 15, 19, and 20, the vertical line with pricks on it, like spitted peas. The tendency is to globular bodies, large broad-bridged lugs and thick bodies; at times there is post-burning colour burnish (A., E.L., P.W.L., P.E.).

Towards the close of the period the quartz admix becomes coarse and is found from Mossel Bay to Port Elizabeth. This period appears to have been due to a fresh Bantu impact from inland.

Gonaqua patterns are strikingly similar to Bantu, horizontal and diagonal lines combined, drag and prick to neck junction. The lips and necks of these pots also show much closer affinity with the Bantu types.

Peculiar changes took place, and cave dwelling was indulged in at times (*e.g.* in the Tzitzikamma and the Transkei) by the descendants of pastoral people who still made good pottery. A clash of cultures took

place and resulted in much imitative and degenerate pottery among Bushmen and half-breeds.

L.A. Type XXIV.—The spread of the potting idea from Hottentot to Bush is most marked in the Transkei-Kaffraria area; the two areas in which the European is only a late settler. There are no essential differences between the Hottentot pottery of Namaqualand and that of inland, or of the Eastern Province. In the latter area there was continuous contact between Hottentot and Bantu, resulting in Type XX, the Gonaqua, pottery. There is very little pottery that can be distinguished as the result of Hottentot-Bush impacts in the west, though probably certain of the Cape Bushman shelter finds of cruder-lugged pottery should be so ascribed. In the east such material is common and cone-based; open bowls, found mainly along the Albany coast, probably belong to this class.

L.A. Type XXV.—While the European advanced along the Eastern Province coast there was contact around the Basutoland Free State border between stone builders and Bush, dating from the first stone-building settlement. The Stormberg mountain area was never inhabited by the pastoral Hottentot, and there is no ceramic evidence that he ever attempted it. Bushmen were driven out of that area only in 1840. The great similarity in the close work on slip that occurs in this area with that of the stone-building area can be due only to direct imitation (Plate XVI, No. 6). A single fragment of close-set ornamentation was found at Kayser's Beach. A fragment has also been found at Koffiefontein, Orange Free State (K., 1843). The slip applied solely for purposes of ornamentation is worked up into a deep coarse herring-bone pattern, close set. That the Bushmen imitated the Bantu methods is certain, the Cathkin Peak caves produced pottery of Bush make (W.W.R.M.S. and 43) with attempts at Bantu burnish, and this is the only area where this has been found, with the exception of the pot from the Kei River cave (Plate XIV, No. 16). Three specimens with shallow Type A lugs (K.) show decoration imitative of Bantu triangles, and the body has a grass admix. Cala shelters (19) produced sherds with taper lips and close-set crescentic decoration; Dordrecht shelters (P.W.L.) sherds with finger-nail patterning, and Zastron, Orange Free State (A., C. 228), a mamillated sherd in a shelter. All of which are paralleled at the nearby source of ceramic ideas, the Free State building culture. The design may be compared with the knobbed bowl (10, p. 169) and soapstone cylinder of Zimbabwe age and culture.

This advance of influence in a south-easterly direction leads to the belief that any of the peculiar Late Stone Age movements in the Transkei were due to the pressure exerted by advancing stone builders or Bantu in the Free State. It was probably that advancing horde, or an earlier

representative, that passed on the technique which produced the Albany ceramic changes among the Gonaquas, Type XX, which shows so many distinctive Bantu traits in its patterns.

In the Stormberg area ornamentation was produced with a flat-ended stick, a half-moon depression, Type 13. A notched stick used for this purpose is illustrated by Dunn (8, pl. xix). With the Bushman it was an instinct to decorate objects. In rare cases a twisted cord was used to impress a pattern. Deep impression with a flat-ended stick occurs at Smithfield (S.A.M., 798, 1836, 1830), Krugerskraal settlement, Koffiefontein, Ladybrand, Cathkin Peak caves (W.W.R.M.S.), Cala. Fine, fingernail impressions occur at Cofimvaba (A.), Tarkastad (L.), Aliwal, Dordrecht, Cala (Hottentot), Middledrift. Patterns made with a notch-ended stick are found at Albert (A., 64 and C. 48).

A pointed stick was used by the Gonaquas. Rims were notched with fine diagonal lines made with a notch-ended stick used vertically, which is essentially a modern Bantu method.

The specimens from the Free State sites are well finished, carefully patterned, with body of Bantu texture; the south-eastern specimens, except those from Kayser's Beach, are on pottery of crude manufacture, *e.g.* the Norval's Pont pot (Albany, plate vii) or bowl, 14 inches diameter, 6 inches in height, a Bantu platter type, raised from the lump over hand, extremely irregular in shape, and doubtless imitative.

This area of heavy, close ornamentation frequently over a slip is restricted to Heilbron, Vechtkop (24), Smithfield, Norval's Pont, Ossehoek (8, p. 83), Graaff Reinet district, Aliwal North, Stormberg, Tarkastad, Middleburg, Dordrecht, Cofimvaba, Queenstown, Cradock, and Kei Road, and rarely reaches the coast. This was essentially a Bushman area, and these products of the Bushman potter ceased *circa* 1840. The Bushman pottery of this type, with its close-set though varied ornamentation, patterns 14, 5–9, 69, 64, 65, was undoubtedly originated in the neighbouring stone-building settlement, which commenced as Bantu and ended as bastardised Bantu-Bush (24), in which circumstances a close connection with the Bush peoples of the neighbouring areas may be postulated. Type XXII probably survived the wiping out of Type XVI in 1823–36 by many years.

L.A. Type XXVI.—The Douglas area, near Kimberley, has produced many Bushmen pots from werfs, which are now in the Kimberley Museum. These are limited in form to open bowls 3 to 6 inches diameter and of variable height, 3 to 5 inches. This is the true Bushman pot, showing few imitative features and developed for definite use. They represent the final phase of Bushman ceramic art.

Section XIV. Stone Age Associations.

Certain finds of pottery in South Africa have been tentatively associated with Stone Age cultures. Van Riet Lowe (50) mentioned Wilton association with pottery in Rhodesia. Goodwin associated Type A lug with Wilton and mentioned plain pottery with quartz admix as "typical of the Later Stone Age." Pottery is stated to be a normal association of the Wilton industry (51), which statement is repeated (51, p. 265) when, concerning open Wilton sites, these writers remark that though bone and pottery are frequently absent "we may presume that they existed." Pottery has been even tentatively associated with the Pietersburg variation of the Middle Stone Age (51, p. 109). That so associated is typically Bantu.

Beneath the foundations of Dhlo-Dhlo ruins, Caton-Thompson found stone implements of the Upper Bambata industry in apparent association with pot sherds of Early African type. The Vumba mountain cave near Umtali also had Early and Middle African pottery over Middle Stone Age. But the Bambata cave, which is the type cave for that industry, showed between Upper Bambata and Early African sherds a considerable layer of Wilton without pottery.

Mumbwa cave pottery is Early African, and it also occurs in an iron-bearing stratum over Wilton.

Cave investigations in Rhodesia suggest that the maker of Early African pottery swept over the Rhodesian Wilton culture which was not a potting industry. The Ezolo cave ceramic material (52), associated in place and time but absolutely separable from the stone-implement industry, precludes Wilton or Smithfield potting. The Ngcisininde Valley cave produced stratigraphical evidence showing the sequence of deposit to be Smithfield stone industry, Transkei III phase plus Gonaqua pottery; early Bantu or pre-Bantu, Sinkwazi type; late Bantu pottery, modern. In four Transkeian caves containing Middle Stone Age strata no sign of pottery was found. The Middle drift site (51, p. 258, and 86, fig. xv, 41) classed as Wilton, contains a few potsherds, claimed to be part of the assemblage, but they are distinctly of L.A. XVII type and of Bantu or pre-Bantu origin. At Ezolo on an open site producing Middle Stone Age and Smithfield implements, sherds of common modern Bantu type are found, which obviously are associated in locality, but not in period of deposition. Of numerous shell mounds of various archaeological period, none earlier than the latest of the Late Stone Age shows the presence of pottery (41). Lowe (51) lists several Smithfield A sites, but only one (Brakfontein) with a fragment of pottery. That pottery illustrated (51, pl. xxxvi) as Smithfield B, is a typical Bantu water or drinking bowl. The "Smithfield" specimen (S.A.M., 798) is also Bantu. Lugs, which it is suggested are

Smithfield (51, p. 169), are non-Stone Age. Quartz admix is limited to Hottentot and Gonaqua. Smithfield A man was without pottery.

Pottery may be common in late Smithfield (51, pp. 183–184), within the Free State, where colonies of Bantu were surrounded by Bushmen, and the state of affairs was similar to that produced by the European who hands on his cast-offs to natives of a type who could not manufacture such garments. The attempts by Stone Age man to produce pottery are recent, as in the south-west and Lake Ngami areas, or the result of bastardisation as at Heilbron, or extremely and crudely imitative as in the Tarkastad area. There is no evidence for the use of pottery by Stone Age man in Africa south of the Zambesi, except possibly within a limited area, in close contact with Bantu, and during recent periods, and there is therefore no such entity as "Wilton pottery," or "Smithfield pottery," nor in the area under discussion is it in the slightest degree possible that pottery will be found as part and parcel of a Middle Stone Age assemblage. Erosion and secondary occupation explain the earlier false association; barter and imitativeness the later association.

In the Isipofu cave there is no direct association between pottery and stone implements. In the Umgazana cave there is, but the pottery has all the appearance of careful Bantu technique.

Section XV. The Essential Similarity of South African Native Ceramics.

The essential similarity of South African ceramics precludes any but a single origin; and, therefore, precludes the various Stone Age associations from being anything more than association in time and place of deposition. The square impression occurs in Kenya; Dithebyane showed a distinct succession from A, comb pattern, and contrasted monochrome to B, less careful work typical of many sites, and to C, an equally distinct type similar to the pottery found at Chwenyane, in which, though square impressions are still used, lip types have changed, and the facies is no longer that of Early African, but of eighteenth-century Bahurutsi. The bangle decoration of Nyassa, Salisbury, Inyanga and Mapungubwe fell out of favour, though the type of bangle that produced it has survived to this day. Staggers, found in Kenya, in the foundation deposit at Dithebyane and at Maokanke, all early cultures, reached their most artistic form at Mapungubwe on the Limpopo during a gold-working age that ceased probably at the commencement of the nineteenth century. Goblet shapes occurred in the Serowe pre-glass bead occupation, in the Modaepae lower enclosures of Chwenyane age, and at Mapungubwe. This Greek goblet or vase has no connection with a classical age, but is the reproduction in earthenware of the calabash

drinking cup. It is merely the drinking cup of Nghdhla, and of last century's eastern Bantu. The platter forms of the stone-building culture in Rhodesia are found also in the early Serowe deposit, in the late eighteenth century deposit at Chwenyane, and are still made, though without the specialised Early African lip, by the Bahurutsi for the covering of pots in the manner found at Dhlo-Dhlo, where an oriental bowl was placed to similar use. Ribbed pottery found in the early Serowe deposit, in the chief's topmost enclosure at Inyanga and Niekerk, is still made for chief Manyani at Mochudi, near Zeerust. The banded type found at Zimbabwe and Chiwona occurred also at eighteenth-century Sinkwazi and nineteenth-century Nghdhla. Bowl forms are universal from early Dithebyane and Mapungubwe, to late Chwenyane and to modern Bantu. From pre-Zimbabwe walled kopjes, through the Zimbabwe building phase to the post-building occupation of Chiwona, or the coastal deposits of migrating Bantu at Sinkwazi and East London, or of starving modern Bantu at Nghdhla are present links of ornamentation, form, and lip treatment. Border lines in period and area are ill-defined, but sufficient evidence is available to show that from two early and characteristic types have evolved strongly developed smaller tribal areas, which, in their turn, have been affected by later migrations. The pulsation of migration, slow at first, and apt to peter out in the far west and south, was speeded up at the periods of the fall of Zimbabwe, Dhlo-Dhlo, Mapungubwe, Heilbron, and Chwenyane. Because of this Chibvumani and Chiwona affinities are found in mass at Sinkwazi and in fragments near East London. Pattern 57, a favourite at Mapungubwe, is found again at Middledrift, near East London.

Bantu influences are apparent in the globular beer pots of the Ovambo and Herero. They are smaller than those of the eastern and central parts of the Union, and rarely exceed 18 inches in diameter, many are ornamented with mamillae and are colour-burnished.

Spouted pots are common throughout the prehistoric deposits of Cyprus and Palestine. Spouts also are common in the Islamic pottery of the present era. Direct Islamic influence cannot be claimed for the spouted pottery of South Africa as it correctly is for those of the Sudan. The multiple vertical-mouthed water jars made occasionally by Bavenda and Zulu are not true spouted pots. It is probable that in North Africa spouted pots have always formed a portion of the ceramic assemblage.

In the west the Hottentot ceramic art disappeared with the appearance of the European and fresh Bantu influence came in north-east, too late to affect it. In the Cape a similar state of affairs prevailed. In the east the Hottentot type of pottery was superseded by a potting industry showing Bantu affinities, and gradually developed away from the Hottentot

fine thin types to the thick coarse ones of the Gonaqua. Meanwhile, the Sinkwazi type migrated along the coast, to be itself, with the Gonaqua, overshadowed by later Bantu migration. Periods of climatic stress followed and degenerate types appeared. The Bushman of the Late Stone Age knew no pottery. True Wilton in the eastern Cape is free from pottery. The only Bushman pottery is that in the east evolved from contact with the Bantu of the stone-building culture and consequent imitation. The essentially similar origin of all native forms of South African ceramic art is shown by the affinities between early Hottentot and early cave Type III, the strong predilection for Early and Middle African patterns and methods in all areas in which natives were in contact with that virile and artistic race. South African indigenous ceramic art begins with the Early African and ends with the Bantu. Hottentot and Bushman potters showed virility and close affinities for a while. Bantu alone remains.

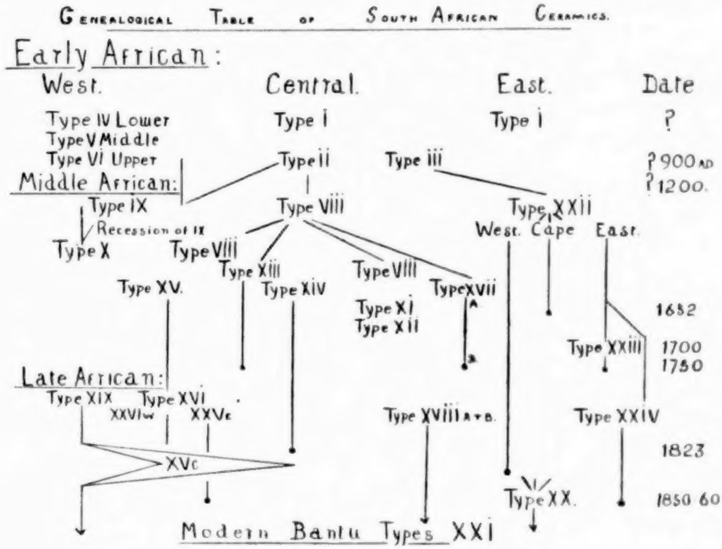
Section XVI. Chronological Classification.

The Hottentot of Little Namaqualand received no direct Bantu impacts until recently and too late to affect his native potting. That area does not produce any pottery of characteristic Bantu types, or of ornamentation, both of which appeared so strongly in South-West Africa during the eighteenth and nineteenth centuries. At the Cape Peninsula the Hottentots lost their ceramic art soon after the appearance of the European (1652), and this assists in fixing end dates for Type XXII at well before 1700 in that area. The Bantu exterminated or drove out the Bush-Hottentot or Gonaqua from the region between the Fish and Kei Rivers during the middle years of the eighteenth century, into the Tzitzikamma. The Bantu, in turn, were followed by the European during the early years of the nineteenth century. The Bantu had already displaced the Bushman along the Transkei and Pondoland coast, though he did not displace him from the inland hilly districts of the Transkei until the middle years of the nineteenth century. This suggests the period 1700–50 for Type XXIII in the Transkei. Type XVII, A, appears to be later. According to Barrow (53) the migrating Bantu met the Hottentot at Umzimvubu River (Port St. John's), 32° east, which is the limit northwards of Hottentot pottery.

The Voortrekkers of 1830 onwards never mention any race living in or using stone-built enclosures. The movements of the former were eased by the raids of 1823–35, which depopulated wide areas. Certain travellers mention the use of such enclosures between the years 1800–20, and one, Kureechanee, had been recognised (54). So taking the year 1800 as the end date for the final bushmanisation of the stone builders at

Heilbron (24) (after which Stone Age man crossed the site), and allowing three generations of twenty years each for that purpose, an end date of 1740 is arrived at for XIX, A. A further series of three generations, for the development of that type, gives a date of A.D. 1510 for the appearance of the Heilbron culture. It is probably much earlier.

Dithebyane and other sites show that there are at least three stages of development within the Early African period. The date of approximately 1400 is therefore suggested for the migrations which produced



TEXT-FIG. xvii.

Middle African, and this date is supported by the evidence adduced from beads (22) and from the calculations based upon midden deposit and succeeding architectural phases (24). The beginnings of the Early African are therefore probably earlier than the thirteenth century.

The similarity between the Chwenyane dated assemblage and that of the modern Bahurutsi of the same area is striking. Its affinities with the Serowe foundation assemblage is also striking, but it is separated from this by the use of staggers and early platter and lip forms, which are more common in the earlier assemblages of Southern Rhodesia. The Chwenyane-Bahurutsi complex is that of Aasvogelkop, near Johannesburg, of Heilbron A and G, and has affinities with the modern Basuto product, a tribe of Bahurutsi descent.

The genealogical table on p. 165 shows how well dates and culture contacts fit together, and how closely knit is the relationship within South Africa. The northerly origin, in two types, themselves probably offshoots of a single type north of the Zambezi, and with successive offshoots along tribal lines, is strongly suggested.

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Section XVIII. Author's Note.

This paper was unfortunately mislaid after its revision and return during August 1936. Shortly after its recovery the volume on Mapungubwe edited by Professor Leo Fouché was published. A unique opportunity is, therefore, given to check the conclusions arrived at in this paper, which, in the opinion of its writer, will need no alteration. The work of the physical anthropologists at Mapungubwe contradicts the conclusion reached by the expert on ceramics, that Mapungubwe is Bantu, and corroborates the essentially Early African origin of the ceramic material. The Heilbron skeletal material will need to be restudied. It is now strongly suggested by the work of Dr. Galloway and his team that the Bantu brought with him into Southern Africa no complete cultural practice, and this is supported by the ceramic evidence of this paper. It is certain that the influence of the Early African culture can be traced in modern Bantu wares, as in the comb patterns of the Bahurutsi. It is probable that the Bantu absorbed much of the culture and ceramic method of their Early African predecessors of Bush-Boskop blood. It appears that the final vindication

of van Riebeeck's Hottentot interpreter Eva cannot be long delayed, and that the connection between the Hottentots and the people of the stone-building culture was a close one. It is foreshadowed above in the description of Early African Type III, and strangely paralleled by the finds of flat-topped Mamillae surrounded by concentric circles of prick marks found both at Ezolo and other more southerly Hottentot sites, and also at Mapungubwe; and there is a similar parallel in the use of spouts in Type III, and at Mapungubwe, and on Hottentot sites. This, with other evidence, suggests a date of origin for the Hottentot previous to the southerly migrations of the Bantu, and also suggests that their origin lies within the sphere of influence of the people of a widespread Early African potting culture.

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DESCRIPTION OF PLATES.

The letters in brackets refer to present whereabouts of specimens.

PLATE X.

Nos. 1–6. Early African, Type III, from Rhodesian caves (N.J.). Nos. 4 and 5 are the Bantu prototype of the Hottentot string-marked pot. Nos. 2, 3, and 6 are typical early African, Type I.

Nos. 7–10, 12–5, and 27. Dithebyane Terrace, lower occupation, Type IV. Nos. 9, 14, and 27 show appliqué bands. No. 20 is typical of the site, No. 14 is typical Early African comb pattern. No. 21, Early African comb pattern, combined with later geometrical pattern, typical of this western area (P.W.L.). Nos. 29–32, Bambata (N.J.).

Nos. 18, 19, 24–27. Dithebyane Terrace, middle occupation (P.W.L.), Type V.

Nos. 11, 16. Bambata Cave. Type III (N.J.).

No. 17. Bambata Cave, spout (N.J.).

Nos. 22, 23, 28, 33, and 34. Mumbwa Cave (W.W.R.M.S.).

Nos. 29, 30, 31, 32. Type I. Bambata (N.J.).

Plate XI.

Nos. 1–9. Type XIII, Mapungubwe. No. 4 is an imperforate whorl. No. 6, a highly burnished graphite black rim with regular and geometrical decoration characteristic of this site. No. 8 and No. 9 show two variations of prick filling, which occurs widely spread (see Plate XVII) (P.W.L.).

Nos. 10, 11, 13, 14, 16–18. Type XVII, "Sinkwazi"; Umhloti, Natal (P.W.L.).

Nos. 12, 15, 19. Type XVII. Kayser's Beach, East London (P.W.L.). It has been suggested that the Kayser's Beach specimen, No. 15, is a photograph of that specimen from Tinley Manor, illustrated by Schofield (55, fig. 1, No. 26), and presumably later sent to the writer. A comparison between this photograph and that sketch shows at least seven differences, all of importance. Such a claim is double-edged. It might with equal danger be claimed that all other affinities between Kayser's Beach material and that of the northern coast are of similar origin.

Nos. 20–25. Specimens of close decoration. No. 20 is a fragment of Bushman, possibly hybrid, bowl (similar to pot from Norval's Pont, Type XXIV (A), illustrated in Plate XVI, 6). No. 21 is a Heilbron fragment of small drinking bowl in herring-bone (P.W.L.). No. 22 from Ladybrand area, O.F.S., age uncertain, is closely decorated with horizontal lines of impressed crescents, deeper at the arc, where also they are burred (P.W.L.). It is comparable with the modern Pondo pots illustrated in Plate XVI. No. 24 is a close, oval comb decoration on a late Hottentot pot, thin walled, from Kayser's Beach. No. 25 is a fragment of a pot, probably Bantu, also with close-set crescentic ornamentation.

Nos. 26–34. Bichrome pottery, and contrasted monochrome. Nos. 26, 27, 29, and 30 are from the Heilbron area, O.F.S. Type IX (P.W.L.). Nos. 28, 31, 33, 34, are from Khami, Type X. No. 32 is modern Basuto, and shows a prick infilling similar to that on No. 30, from the much earlier stone-building culture at Heilbron, and Nos. 8 and 9 from Mapungubwe in the Northern Transvaal (P.W.L.).

Plate XII.

No. 1. An internally reinforced lug, Type A, from Le Cateau, Grahamstown (A.).

No. 2. A more prominent, broad-bridged lug, Type A, late from Koonap, on pot of Type XXIII (A.)

No. 3. Side view and section of wall, showing reinforcement, internal to pot wall. This lug has a mamilliform bridge (A. 1020), and is on a pot of Type XX.

No. 4. Mamilla, solid, with concentric lines incised, and prick impressions. Albany (A.)

No. 5. Small bowl, perforated lip lug of Type G, on a pot of Type XXIV (A.). From Craigie Burn, Somerset East.

No. 6. Repoussé mamilla, inner surface (A., C. 983) on pot from midden at Kleinemonde, Bathurst district.

No. 7. Internally reinforced, broad-bridged lug on shoulderless pot with a rim of Bantu facies. Schoenmaker's Kop, Port Elizabeth. (A. 1020.) Pottery Type XXIII.

No. 8. Externally applied handle lug on a wide-mouthed pot with tapered or rounded lip (A.). Lug, Type H; pot, Type XXIII, probably.

PLATE XIII.

No. 1. Leather "pot" of Bushman origin, from Barkly West, leather-plaited neck, sewn on to belly. Twelve inches high (K.). Photograph reproduced by courtesy, MacGregor Museum, and also:

No. 2. Neck in pottery, with perforated lower edge to sew on to leather belly, as in No. 1. Five and a half inches high (K. 1405), from Kleinkaras, S.-W. Africa. Pottery Type XXII, west.

No. 3. A spouted pot from Kleinzee, Little Namaqualand. Eight and a quarter inches high. Comparable in technique and ornamentation with Eastern Province specimens, Nos. 4, 5 (K.).

No. 4. Spouted pot, Kayser's Beach, near East London, restored and repaired with plaster of paris. Pottery Type XXII, east. The squared rim and vertical incisions suggest Bantu influence, and it therefore probably represents a transition period between pot Types XIX and XX (P.W.L.).

No. 5. Spouted pot, Dunbrody, Sundays River (A.). An exactly similar spout, not illustrated, was found at Kayser's Beach. Type XXII or transition to XXIII.

PLATE XIV.

No. 1. Inner aspect of base of pot from Port Nolloth (H.), showing ammonite spiral where the finger was withdrawn from the pot during the construction of its wall by the ribbon method. Such bases are usually reinforced externally by a slip. Pottery Type XXII, west.

No. 2. Squared, vertical lip, on sloping shouldered pot decorated with string marking XXII–XXIII. Port Nolloth (P.W.L.).

No. 3. Pot from Rufanes River mouth (A.), ovoid, shouldered, almost vertical neck, thin body, overlapped and trimmed lip, string-patterened neck. The type pot of Type XXII.

No. 4. Overlapped trimmed lip, string marking, and impressed pattern. Pot thicker walled and more globular. Gonaqua. Type XXII, East London, Buffalo River shell mounds (P.W.L.).

No. 5. Fragment of pot, East London shell mounds, neck ornamented with single horizontal groove, and a row of vertical, right-handed pricks, Type XXII (P.W.L.).

Nos. 6–11. Kayser's Beach, East London. No 6 is a fragment of small bowl, vertical neck, band of incised criss-crossed lines, and vertical repoussé lug. Of strong Bantu, especially Sinkwazi, affinities, and probably a late representative of Type XXIII. No. 7 shows a double vertical row of impressed marks on a body of thin Hottentot facies. No. 10 is similar. Nos. 8 and 9, two types of Hottentot rim, the latter with shallow string pattern on neck. No. 11 is a fragment of another late Hottentot pot, with a vertical triple row of impressed ornamentation (P.W.L.).

No. 12. A fragment of thin bodied pot, Dunbrody, Sundays River (A., *c.* 1079), repoussé ornamentation, externally borderd by round impressions.

No. 13. A conoid pot, wide mouth, slightly overlapped lip, peculiar to shell mounds of Albany area. Probably Type XXII. Rufanes River (A.).

No. 14. Pot, shouldered, with sloping neck, and trim grooves to imitate trimming of consolidated neck-body and overlapped lip. Lug internally reinforced. A degenerate member of Type XXII. From near Committees Drift (A.).

No. 15. Vertical-sided pot, round based, with large semi-disc mamillae (the term lug can hardly be used here). Found at Balfour, C.P., containing human bones. Is of the degenerate and late stage of the stone-building culture (A.).

No. 16. Vertical-sided pot, round based, rounded and nicked lip, raised from the lump, surface slightly burnished as in the Cathkin Peak specimens (W.W.R.M.S.), from a Bushman shelter on the Kei River. Is imitative of Bantu. Type XXV (P.W.L.).

Plate XV.

No. 1. Pre-dynastic Egyptian pot. Conoid base, ribbon technique (A.).

No. 2. Sherd from Elmenteita (A.). Leakey's Gumban A (A.).

No. 3. Close-set ornamentation. Scanlan. Kissack Collection (A.).

No. 4. Another (A.).

No. 5. Five sherds from the stone-building culture sites, Heilbron area. Varieties of close ornamentation (P.W.L.).

No. 6. A unique pattern. Khami. Kissack Collection (A.).

Plate XVI.

Nos. 1 and 3. Modern Pondo. No. 2, Modern Pondo. Compare patterns with Plate XI, No. 22 (E.L.).

No. 2. Pot belonging to second occupation of Mchuchu, S. Rhodesia. Comb prick and drag round neck, similar to modern Bavenda, and found also at Mapungubwe (P.W.L.).

No. 4. A pot of Type XVII, "Sinkwazi." Right diagonals, followed by incised left diagonals, forming a small and crude lozenge pattern. From near the Country Club, Durban (D.).

No. 5. Six specimens from Domboshawa, Bech. P., the first of which shows the pique rim found also at Heilbron (P.W.L.).

No. 6. A pot of Bushman origin, crudely raised from the lump over hand, with close-set grass rope or bangle decoration. Type XXV from Norval's Pont (A.).

No. 7. Zimbabwe. Illustrated by MacIver plate xxxv (26). The ridge between the horizontal incisions is divided by vertical incisions, a method that reaches artistic heights at Mapungubwe, in panel decoration. It appears to be limited to the N.-W. of the Union. Though the ornamental principle is similar to that of No. 4, its employment is distinctive.

No. 8. Two specimens of rolled and everted lips, Khami (N.J.).

Plate XVII.

No. 1. A stone pot burnished from Chwenyane, near Zeerust.

No. 2. A modern Bahurutsi pot, stone burnished (P.W.L.).

Nos. 3–4. Square impressions, comb, in suspended triangle design. Chwenyane dated deposits (P.W.L.).

Nos. 5–8. Comb impressions. Chwenyane, royal enclosure middens (P.W.L.).

No. 9. Nicked rim, similar to that found in a boguera deposit at Lobatsi, and in the middle occupation, Heilbron, and in modern pottery. From Chwenyane dated deposit (P.W.L.).

No. 10. From site of a deserted kraal, Ezolo, Transkei (P.W.L.), a decoration of suspended triangles filled with diagonal pricks, and left diagonals, comparable with specimens from Mapungubwe. Date, *circa* 1850?

No. 11. Modern Bahurutsi pot (P.W.L.), Zeerust area, with ring base, handles, and cover with a mamillated handle which in older deposits may be taken for an amphora base.

No. 12. Modern Basuto, Matitzi's Kop, Zoutspanberg. Ring base, and handled, triangle decoration filled with diagonals (A.).

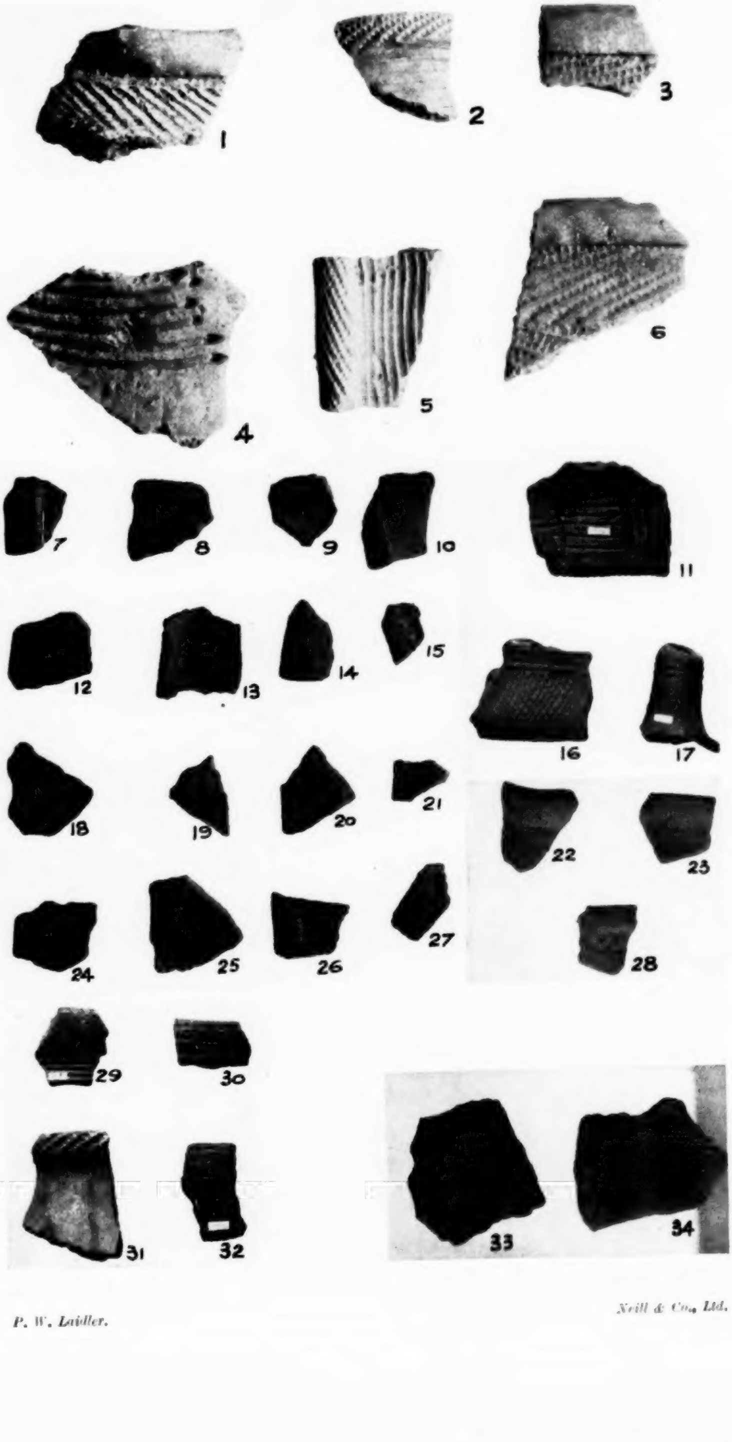
No. 13. Modern Basuto (A.).

No. 14. Modern Basuto, Masite, Basutoland (A.).

No. 15. Modern Basuto, Ladybrand area, O.F.S. Boy's drinking cup. Cone base, rolled lip decorated with supported triangles, and an unusual criss-cross decoration incised and painted (P.W.L.).

No. 16. Type XIX from open sites in Heilbron area (P.W.L.).

No. 17. A lozenge pattern common to building-culture areas, Mapungubwe and Heilbron. The specimen illustrated is from the latter place. Early Basuto or Bahurutsi. Type XIX (P.W.L.).



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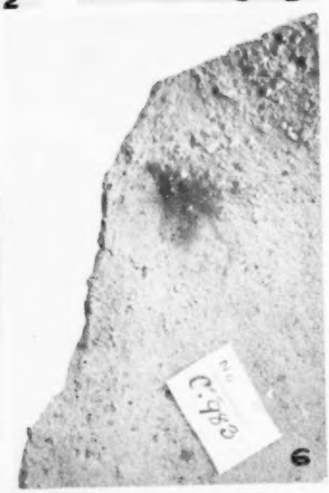
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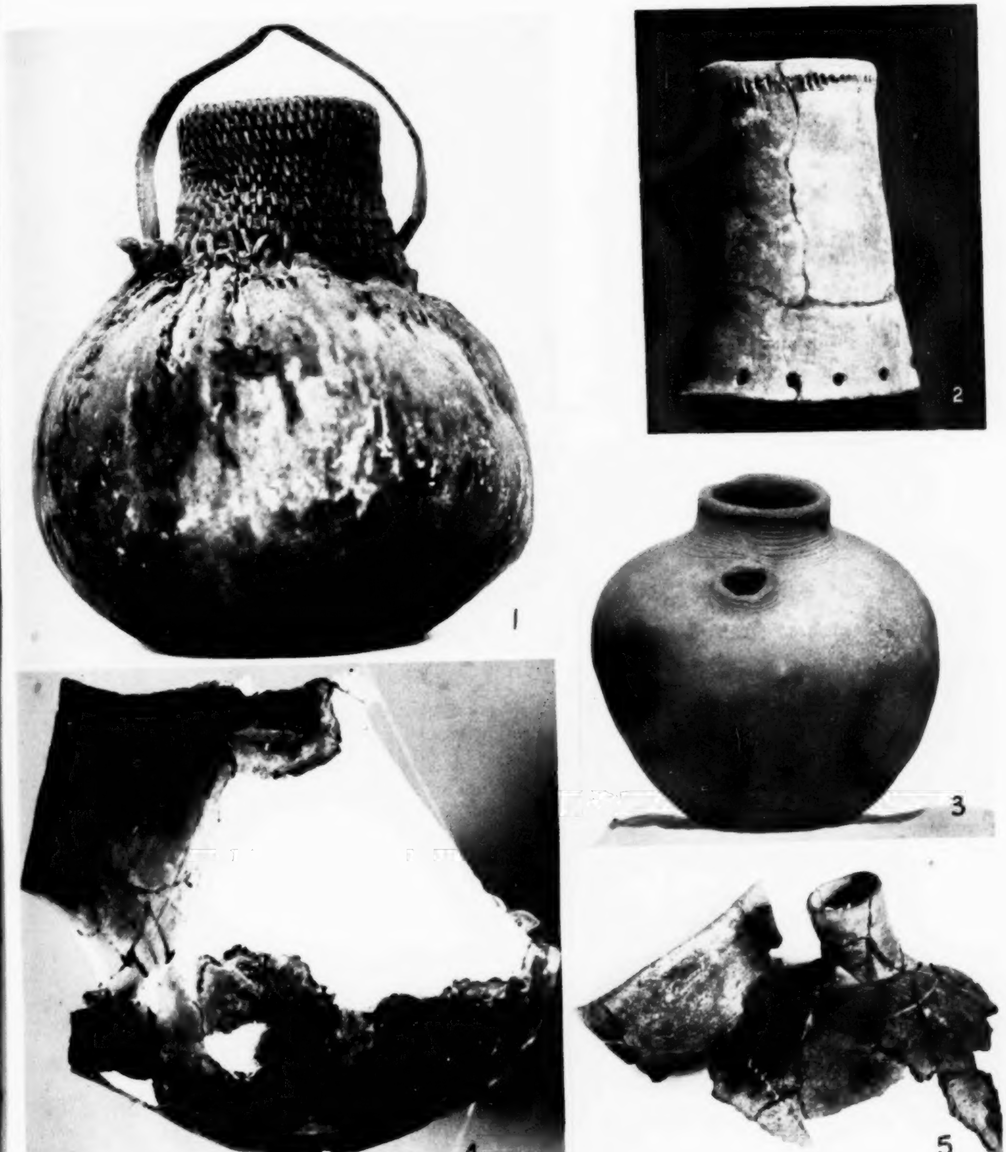

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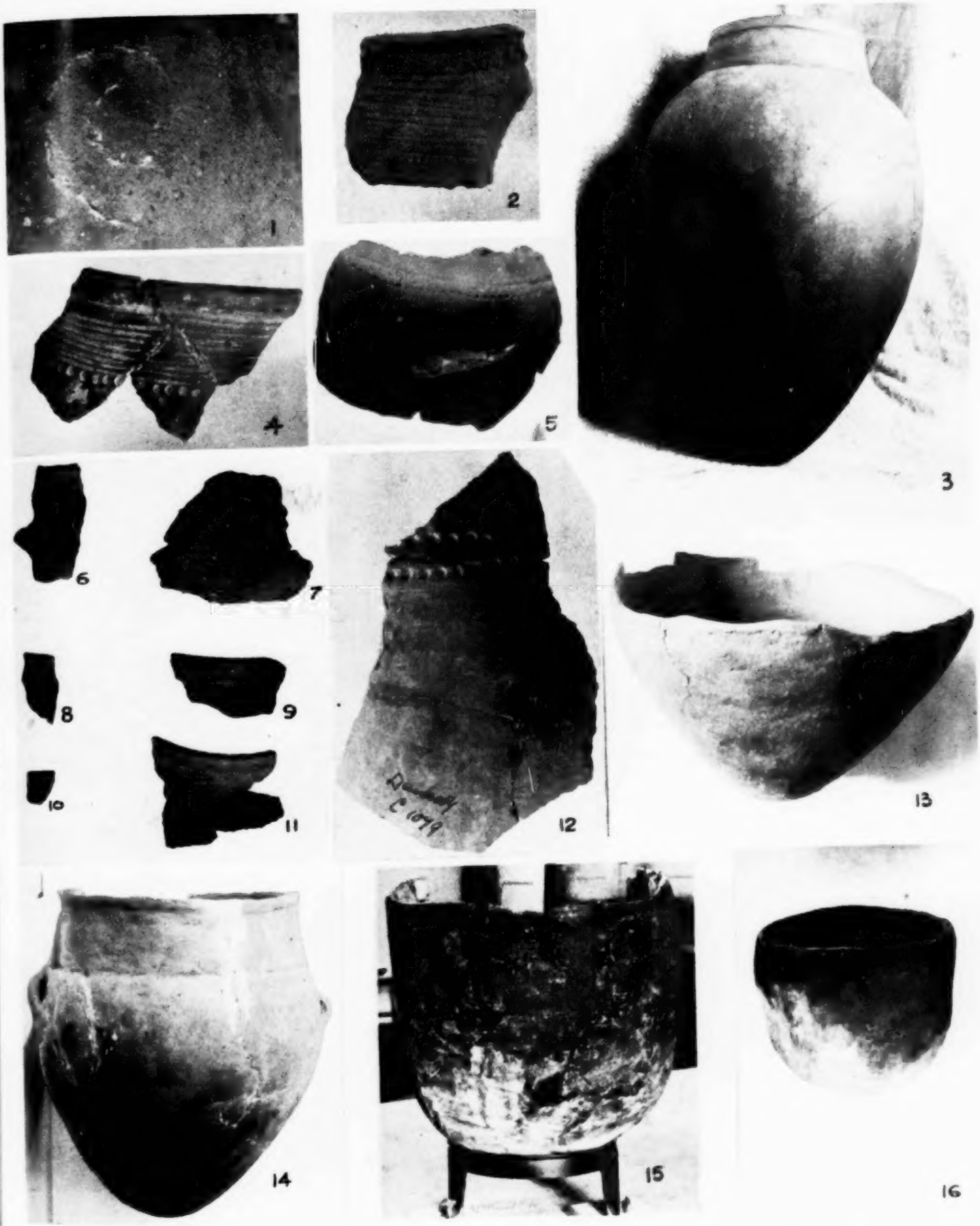

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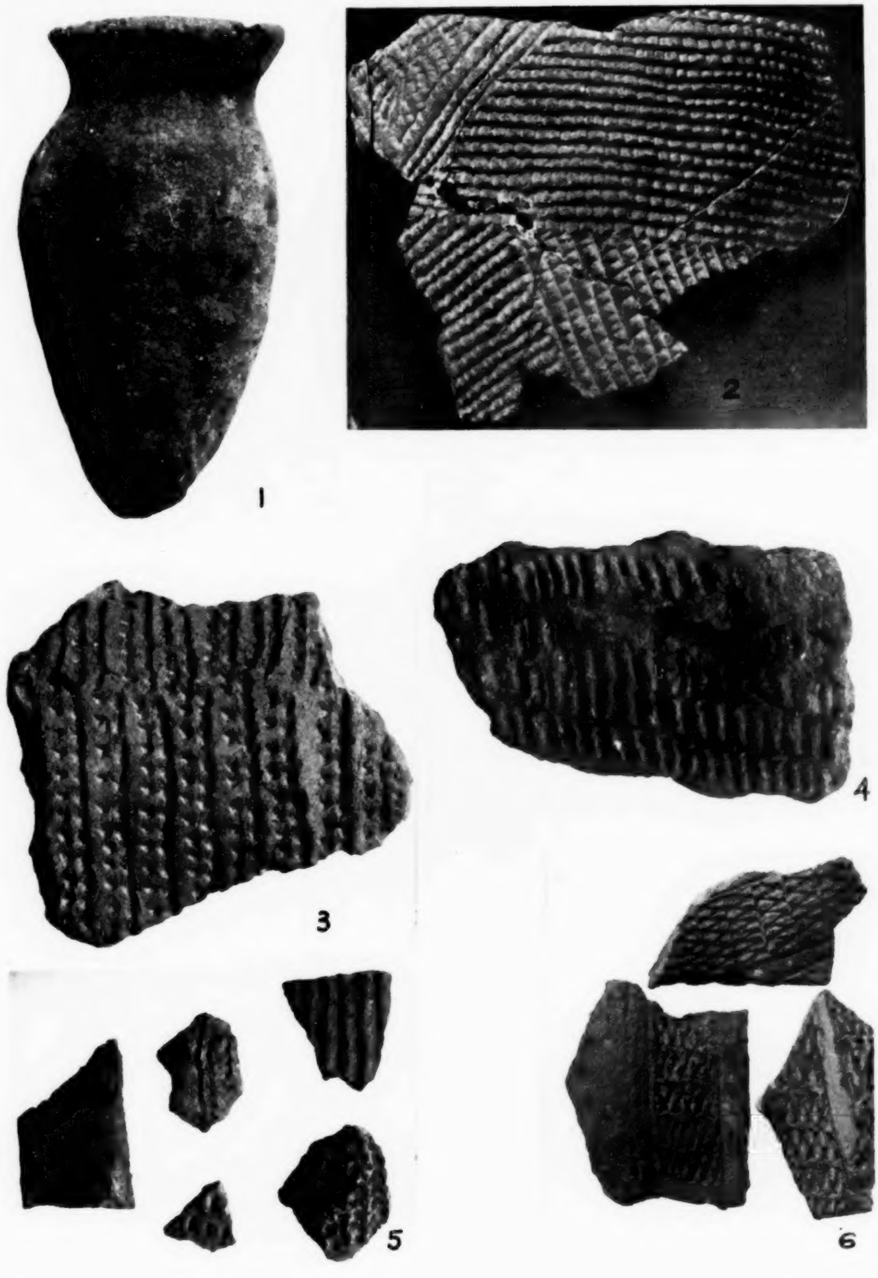

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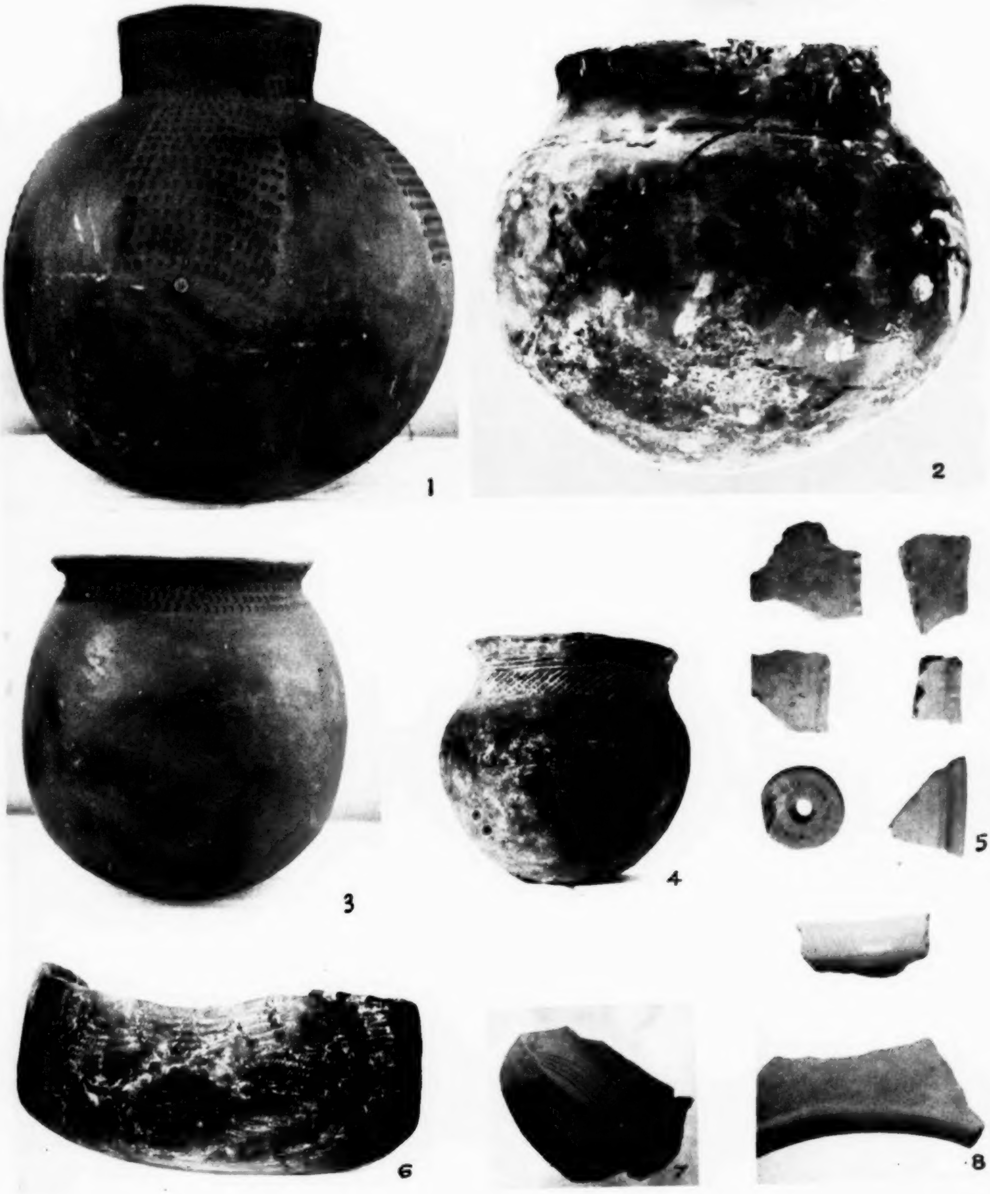

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A STUDY OF THE SOUTH AFRICAN SPECIES OF *SPOROBOLUS* R. BR., WITH SPECIAL REFERENCE TO LEAF ANATOMY.

By A. P. Goossens, M.Sc., Ph.D.,
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(With thirty-one Text-figures.)

Introduction.

In view of the importance attached to the anatomy of grass leaves for taxonomic purposes, and in order to continue the line of research started at this institution, a study of the South African material of the genus *Sporobolus* R. Br. was undertaken. This genus was selected because it was all along found to be a difficult task to identify the majority of the known South African species with any certainty with the existing classification schemes. Stapf's classification (Dyer, Fl. Cap., vii) of this genus is now much out of date, while the more recent classification of Stent (1927) is in many ways very vague and based on rather indistinct external characters. For instance, much stress is laid on length of culms, width of leaf, etc., which are all variable unreliable characters; and even new species are based on such indistinct and unreliable characters. In many ways, too, her monograph is not so complete as it could have been, for species like *S. spicatus* Kunth, *S. Sladenianus* Bolus, and *S. nebulosus* Hack., which were described and recorded from South Africa long before her monograph appeared, are not included; the distribution of the species is not fully given, as many specimens which were collected long before 1927 are left out without any reason; the proofs of her manuscript were evidently not properly corrected, for the name var. *laxus* (Nees) Stapf was omitted on page 271 in Bothalia, ii, 1*b*, although its distribution is given; and neither is the material of the species recorded from South-West Africa included in that publication. It was, furthermore, felt that the anatomy of the basal leaves would probably provide very valuable characters, which could be applied with much advantage together with the external features, to identify the species with greater certainty and to study the relationship of doubtful species.

Stapf, *loc. cit.*, was the first to revise the South African material of this genus, to which he refers 12 species and 1 variety. These he grouped into

two sections, viz. *Eu-Sporobolus* with 11 species and 1 variety, and *Chaetorhachia* with 1 species. His classification is based on external characters only, and much stress is laid on such variable features as length of culm, width of leaf, length of panicle, etc.

Miss Stent (1927) gives a detailed account of the history and nomenclature of this genus, which need, therefore, not be repeated here. She distinguishes 28 species and 1 variety occurring in South Africa. Of these no less than 13 are newly described by her (1924, 1927). She differs from Stapf in being of opinion that his *S. festivus* var. *stuppeus* exhibits enough distinct features in which it differs from the closely related *S. festivus* to raise it to specific rank.

From a closer study of the external morphological features as well as the anatomical characters of the basal leaves, it was possible to distinguish one undescribed species, *S. transvaalensis*, and a new variety, *S. artus* var. *lysigenatus*. It was also possible to verify the validity of the described species and to clear up several doubtful points in the above-mentioned classifications. For instance, it became evident that *S. indicus* var. *laxus* (Nees) Stapf and *S. pyramidalis* Beauv., as used by Stapf and Stent, are very closely related, and that the former is referable to the latter; it appeared justifiable to refer *S. Gillii* and *S. Vryburgensis* of Stent—both based on mere ecological or edaphic and climatic variations—to *S. iocladus* Nees; it was found that *S. filifolius* Stent and *S. laxivaginatus* Stent are probably variations of *S. centrifugus* Nees, being linked up by transitional forms; and no anatomical evidence was found justifying the maintenance of *S. stuppeus* (Stapf) Stent as a species.

In the subsequent pages of this paper a key to the species is put forward, based on their external morphological features in co-operation with the anatomical characters of their basal leaves. It was not possible to compile a key on the anatomical characters only, as Theron (1936) was able to do in the case of the Aristidas. This may be possible in certain homogeneous genera, but on the whole I consider it advisable to use the external morphological characters in co-operation with the anatomical characters of basal leaves, and in some instances perhaps also of the roots, as Phillips and Bredell (1937) were able to do with the South African species of *Elyonurus* H. and B. In all the cases, therefore, the external morphological features and descriptions of the species have been critically examined as well.

Several research workers have already acknowledged the value of the anatomy of grass leaves from a systematic point of view. Some have mainly stressed the epidermis of leaves, while others have confined themselves to the organisation of the leaf tissues. Some have also endeavoured to correlate the internal leaf structure of the various grasses with their environment, and to divide them into ecological groups.

As far as the South African grasses are concerned, Goossens and Theron (1934) have endeavoured to identify the varieties of *Themeda triandra* Forsk. on the anatomical features of their basal leaves. Much stress is laid on the number and the position of the motor cells, and on the epidermal cells as seen in surface view.

Phillips and Bredell (1937) found the anatomical characters of the roots and leaves of much importance in classifying and identifying the South African species of the genus *Elyonurus* H. and B.

The anatomical features of the leaves given in the subsequent pages are based on the features seen in cross-sections made about 5 mm. above the ligule of full-grown basal leaves. More stress was laid on the abaxial epidermis as seen in surface view, as the adaxial epidermis does not come away so easily as that of the less prominently ribbed abaxial side. It was found advisable to boil the leaves for a few minutes in the case of dried material to expel the air from between the ribs and to soften them prior to cutting the sections, the time of boiling depending on the thickness of the leaves. After boiling, the abaxial epidermis readily comes away. The sections were preferably cut by hand, and the drawings are exact representations of these and were made with the aid of the Panphot apparatus.

Where possible, fully developed, more or less mature basal leaves of the type or co-type were studied. Where neither of these could be had, basal leaves of a representative specimen were kindly supplied by the Kew Herbarium. This has served as a basis for further comparative study.

I am very much indebted to Mr. F. S. Muller for his willing assistance in carrying out most of the anatomical researches from which these notes have been prepared. I am, however, responsible for the general plan and initiation of this work, which I have also supervised and directed throughout. I am also very much indebted to the Chief, Division of Plant Industry, Pretoria, and to the Directors of the different South African herbaria, for kindly placing their material of this genus at my disposal: to the Director of the Royal Botanic Gardens, Kew, for kindly supplying me with leaf specimens of the types or co-types, or, failing these, of representative specimens; and to Mr. C. E. Hubbard of the Kew Herbarium, to whom some of the specimens were referred for verification, for the very valuable comments he made on specimens sent to him.

The Leaf Anatomy.

Leaves are known to be extremely sensitive to changes in the environmental conditions, and it was therefore found necessary to study the variability of the different chosen anatomical features. It was practically

impossible to make field studies, but as I had at my disposal in the majority of cases a fair amount of material collected from all over the country and representing different habitats, it was possible to make a careful study of the various characters and judge their suitability or unsuitability for taxonomic purposes. The variability of the chosen features within one and the same leaf and between the differently placed leaves on the same plant was also studied. It was found that the general character of the features remains more or less constant right through one and the same leaf, but that, on the whole, these are better discernible towards the base of the leaf. It was also found that these features remain more or less the same in differently placed leaves on one and the same plant. Mature basal leaves are, however, preferred, as they are sooner full grown, are better developed than culm leaves, and exhibit the chosen features much better. Furthermore, this study is based on full-grown basal leaf specimens of types and co-types which were kindly supplied by the Kew Herbarium, as well as the external morphology of the species. The collections I had at my disposal provided the opportunity of studying the variability of these features, not only between the leaves of different plants of the same locality, but also between the leaves of the same species from distinct localities and conditions.

As seen in transverse section, the leaves of the majority of the species appear to be flat and fairly thin, and also possess a distinct midrib as well as a prominent abaxial keel. On either side of the latter the leaf-blade appears relatively thin, as Tschirch (1882) found to be the case with the pasture grasses he studied. A number of the species, however, are devoid of a well-defined midrib and keel, the leaf appearing of the same thickness right through, except the margins, which are thin and acute. A single species, *S. subtilis* Kunth (fig. 31), develops relatively thick rigid leaves, which appear more or less circular in cross-section.

The following two main types of leaves could be distinguished: (*a*) those with a distinct development of one or more layers of parenchyma in the midrib region; and (*b*) those without parenchyma and distinct keel. There may be an indication of parenchyma in the leaves of certain specimens, but in such cases there is no distinct keel or midrib region. A few species, *S. capensis* (Willd.) Kunth and *S. artus* Stent, belonging to the former type show a marked development of lysigenous cavities in the parenchymatous tissue. This phenomenon appears to be constant in the first-named species, while it occurs in varietal forms of *S. artus*. Lewton-Brain (1904) has observed such cavities in the leaves of *Molinia caerulea*, and uses it for taxonomic purposes.

The vascular bundles in the different species generally possess the same organisation, although the different tissues often show some variation.

The bundles can also be divided into different orders according to their development. In *S. robustus* Kunth, for instance, at least 4 different orders can be made out. In this grass the bundles of the second order often show a tendency to develop into first-order bundles. Vickery (1935) observed a similar feature in certain grasses she studied. In most cases the number of bundles and the relation between the different orders varied considerably in the leaves, not only of the different species, but also of the members of a species, and consequently it was not possible to use it for taxonomic purposes as successfully as Theron (1936) was able to do in the case of the genus *Aristida*.

All the species possess a double bundle-sheath of which the outer can be clearly made out from the surrounding tissues, often being interrupted by the abaxial stereome strands, especially in the case of first-order bundles.

According to the arrangement of the chlorophyll tissue, two more or less distinct types of leaves can be distinguished. The first type, which represents the majority of species, possesses a very regular organisation, consisting of regular elongated cells radially arranged around the vascular bundles. Very often these circular masses are interrupted by both adaxial and abaxial stereome strands. These masses of chlorophyll tissue are often separated by strands of clear cells which extend from the motor cells to the abaxial epidermis. The cells of the chlorophyll tissue of the second type are very irregular in form, and not radially arranged round the bundles to form definite masses (fig. 27). The arrangement of the chlorophyll tissue is of much taxonomic importance, as Vickery (1935) has also pointed out.

All the leaves are provided with a more or less well-developed mechanical tissue, being in the form of strands above and below the bundles and often extending from the epidermis to the latter. The adaxial strands are usually not so well developed as those on the abaxial side. In leaves with a distinct keel the stereome strands in the midrib region very often fuse, forming a continuous band. In the leaf-margins the mechanical tissue is usually well developed, often fusing with the adjoining abaxial stereome strands to form hood-like structures (fig. 9). In a few cases the marginal mechanical tissue was found to be of taxonomic value, but otherwise this tissue is not of the same importance as Theron (1936) has found in the genus *Aristida*.

The motor cells usually present at the base of the furrows between the adaxial ribs may vary in form and in number. Two types can more or less be distinguished. In the one type a group of motor cells usually consists of 3–5 cells, of which the central cell is larger than the lateral ones and is as broad as, or even broader than, deep (fig. 24). In the other

type the groups consist of 6 or more cells, which gradually decrease in size towards the sides and are deeper than broad (fig. 8). In some species both types occur. In a few instances the position of the motor cells has been found to be of systematic value. For instance, in *S. subtilis* Hack. the motor cells only occur between the main bundle and the first bundles of the first order, instead of between all the ribs.

The abaxial epidermis consists of the same types of cells as described by Grob (1896). The longitudinal walls of the long cells are usually strongly sinuate. The long cells opposite the bundles are much narrower than those in the region between the bundles. The cutinised cells are variously shaped. According to Grob the saddle-shaped cutinised cells are closely related to the cross-shaped ones, and consequently transitional forms are common. In some cases only dumb-bell-shaped cutinised cells are found. Where the cutinised cells and the short silicified cells form definite rows of short cells, the former are relatively large and more or less rectangular, with their walls more or less undulating. As in the case of Grob (1896), the difference in the organisation of the abaxial epidermal cells is found to be of much taxonomic importance. In some cases the epidermal cells opposite the vascular bundles consist of rows of short cells alternating with rows of long cells, while in others it consists of cells made up of groups of 2 short cells (a silicified cell and a cutinised cell) alternating with long cells. In one or two species both types of organisation may be present.

The stomata occur in rows on the sides of the abaxial ribs, but the number of rows between the ribs is not at all constant. In *S. virginicus* Kunth the stomata may be more or less absent.

SPOROBOLUS R. Br.

(Prodr. Fl. Nov. Holl., 169 (1810).)

Spikelets 1-flowered, the rhachilla very short and disarticulating above the glumes; glumes usually unequal, the lower often very small, the upper often as long as the spikelet; lemma membranous, awnless, 1–3-nerved; pale, usually prominent, equalling the lemma or often slightly shorter; seed often free from pericarp.

Perennial or sometimes annual; blades flat, folded, or setaceously convolute; ligule a fringe of hairs; panicle open or spike-like.

Key to the Species.

Section 1.—*Eu-Sporobolus* (Stapf), rhachilla not produced.

† Perennial plants.

* Spikelets 5 mm. long; chlorophyll tissue in basal leaves not forming masses of radiating cells round bundles . . . . 1. *S. artus*.

** Spikelets 3 mm. long or slightly over, brownish yellow or brownish green.
  Margins of leaf not pectinate ciliate.
    Abaxial epidermis opposite bundles in leaves consisting of groups of 2 short cells alternating with long cells; third-order bundles developed opposite motor cells above base of basal leaves . . . 2. *S. centrifugus.*
    Abaxial epidermis opposite bundles in leaves consisting of rows of short cells alternating with rows of long cells; no third-order bundles developed opposite bundles above base of basal leaves . . 3. *S. Schlechteri.*
  Margins of leaf distinctly pectinate ciliate . . . 4. *S. pectinatus.*
*** Spikelets much under 3 mm., if rarely more or less 3 mm. long then not brownish.
  △ Panicle when mature broadly ovate, lax, rarely somewhat contracted but not spike-like, not more than four times as long as broad.
    ⊙ Branches of panicle solitary or binate.
      Axils of panicle bearing tufts of hairs . . 5. *S. Conrathii.*
      Axils of panicle glabrous.
        × Basal leaves not splitting into fibres.
          Abaxial epidermis of leaves consisting of groups of 2–3 short cells alternating with long cells opposite bundles.
            Panicle more or less dense; branches of panicle more or less crowded; keel region of basal leaves not distinguishable; parenchyma absent above base of basal leaves . . . . 6. *S. acinifolius.*
            Panicle scanty; branches of panicle scattered; keel region and parenchyma conspicuous above base of basal leaves 7. *S. Fourcadii.*
          Abaxial epidermis of leaves consisting of rows of short cells alternating with rows of long cells opposite bundles.
            Chlorophyll tissue in basal leaves not forming masses of radiating cells round bundles . . 8. *S. Sladenianus.*
            Chlorophyll tissue in basal leaves forming distinct masses of radiating cells round bundles.
              Panicle open and lax; leaf-blades with obtuse, truncate, or emarginate tips; chlorophyll tissue in basal part of basal leaves separated by strands of clear cells extending from the motor cells to the abaxial epidermis 9. *S. tenellus.*
              Panicle contracted; leaves acute, subpungent; chlorophyll tissue in basal leaves not separated by strands of clear cells . . . . . 10. *S. albicans.*
        × Basal leaves splitting up into fibres . . 11. *S. festivus* vars.
    ⊙ ⊙ All or at least the lowest branches of the panicle whorled.
      Parenchyma conspicuously developed in keel region above base of basal leaves.
        Margins of leaf distinctly undulated; adaxial surface in keel region of basal leaves distinctly ribbed . . 12. *S. nitens.*
        Margins of leaf not undulated; adaxial surface in keel region of basal leaves not ribbed.
          Plants without stolons . . . 13. *S. iocladus.*
          Plants stoloniferous.
            Margins of leaf pectinate ciliate . 14. *S. Smutsii.*

Margins of leaf not conspicuously pectinate ciliate 15. *S. usitatus.*

Parenchyma absent in keel region above base of basal leaves 16. *S. Ludwigii.*

△ △ Panicle when mature long and narrow, contracted and spike-like, rarely lax and open, but then much more than four times as long as broad.

Both glumes equalling the spikelet . . . . 17. *S. robustus.*

Lower glume or both glumes shorter than the spikelet.

Upper glume more or less equalling the spikelet, lower much shorter.

Panicle long, loosely spreading, never spike-like; parenchyma conspicuously developed in keel region of basal leaves. 18. *S. fimbriatus.*

Panicle contracted and spike-like; parenchyma and keel region not distinguishable in basal leaves . . . 19. *S. virginicus.*

Both glumes much shorter than the spikelet.

Abaxial epidermis opposite bundles of leaf consisting of groups of 2 short cells alternating with long cells; keel region and parenchyma conspicuously developed in basal leaves.

Parenchyma in keel region of basal leaves without lysigenous cavities.

Plants without stolons; groups of chlorophyll tissue in leaves separated by strands of clear cells extending from motor cells to abaxial epidermis . . . . 20. *S. spicatus.*

Plants stoloniferous; chlorophyll tissue in leaves not separated by strands of clear cells . . 21. *S. Bechuanicus.*

Parenchyma in keel region of basal leaves always with distinct lysigenous cavities.

Panicle lax, with long, spreading, or obliquely ascending branches . . . . . . 22. *S. pyramidalis.*

Panicle narrow, densely spike-like . . 23. *S. capensis.*

Abaxial epidermis opposite bundles of leaf consisting of rows of short cells alternating with rows of long cells; keel region and parenchyma not distinguishable in leaves . . . 24. *S. transvaalensis.*

†† Annual plants.

Sections above base of basal leaves not circular; abaxial surface of leaves smooth or with many rounded ribs; branches of panicle whorled; upper glume the length of spikelet.

Margins of leaf not pectinate ciliate; keel region and parenchyma conspicuous in leaves.

Spikelets 3 mm. long, greenish yellow flushed with purple; chlorophyll tissue not forming masses of radiating cells round bundles 25. *S. panicoides.*

Spikelets 1 mm. long, olive-green; chlorophyll tissue in leaf forming masses of radiating cells round bundles . . . . 26. *S. argutus.*

Margins of leaf pectinate ciliate; keel region and parenchyma absent in basal leaves . . . . 27. *S. discosporus.*

Sections of basal leaves circular, with 5–7 broad, flat-topped abaxial ribs; branches of panicle solitary; both glumes shorter than spikelet . . 28. *S. nebulosus.*

Section 2.—*Chaetorhachia* (Stapf), rhachilla produced into a bristle half as long or as long as the spikelet.

Only species . . . . 29. *S. subtilis.*

The Species and their Distribution.

1. **S. artus** Stent in Bothalia, ii, 1*b*, 260 (figs. 1 and 2).

Perennial; culms erect, slender, glabrous, 26–46 cm. long; blades flat or involute towards the tip, up to 15 cm. long, about 3 mm. wide;

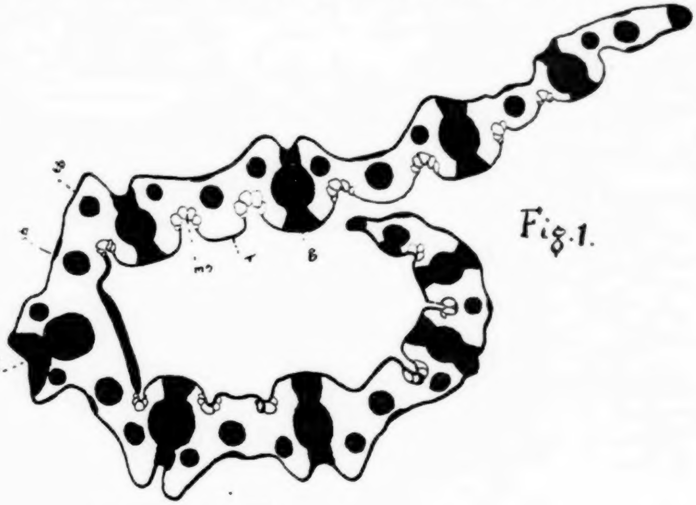


Fig. 1.

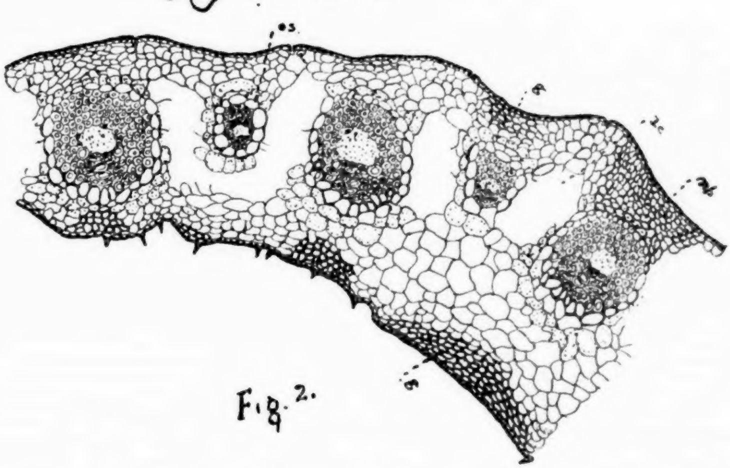


Fig. 2.

panicle spiciform, up to 15 cm. long, the branches scattered or subverticillate, closely appressed; spikelets light olive-green, about 5 mm.

long; lower glume about two-thirds the spikelet, the upper equalling the spikelet; lemma like the upper glume.

Leaf Anatomy.—Keel usually distinct. Abaxial surface undulated or prominently ribbed, with the ribs often prominently grooved. Adaxial surface more or less distinctly ribbed except in keel region, often with few asperities. Mechanical tissue above and below bundles. Parenchyma present opposite main bundle, often only indistinctly represented. Bundles of first order girdered except those in keel region; outer bundle-sheath usually interrupted by abaxial stereome strands. Chlorophyll tissue not forming masses of radiating cells round bundles. Motor cells usually distinct between ribs. Abaxial epidermis opposite bundles consisting of rows of cells composed of groups of 2 short cells alternating with long cells; stomata in 1–3 rows in region between bundles (*S. centrifugus* var. *angustus* Nees in Fl. Afr. Austr., 159, 1841).

NATAL.—Without precise locality, *Wood* 6009 (*Natal Herb.*). Phoenix, *Schlechter* 3128 (*Alb. Mus. Herb.*); *Wood* 1578 (*Natal Herb.*). Winklespruit, *Franks* 11894 (part of type in *Herb. Mus. Austr. Afr.* and *Natal Herb.*). Alexandra, *Rudatis* 726 (*Natal Herb.*).

TRANSVAAL.—Benoni, *Bradfield* 294 (*Nat. Herb. Pret.*).

var. **lysigenatus** Goossens, var. nov. (fig. 2).

Lysigenous cavities develop in the parenchyma in keel region; motor cells distinct.

NATAL.—Inanda, *Rehmann* 8254 (*Alb. Mus. Herb.*). Claremont, *Schlechter* 3044 (*Alb. Mus. Herb.*).

2. **S. centrifugus** Nees in Fl. Afr. Austr., 158 (fig. 3).

Perennial; culms slender, erect, glabrous, up to 30 cm. high; blades flat, tapering to a convolute apex, up to 11 cm. long, 2–4 mm. wide; panicle narrow ovate, up to 7·5 cm. long, 2 cm. broad, branches whorled, obliquely ascending; spikelets about 4 mm. long, yellowish brown; lower glume about three-quarters the spikelet, upper glume equalling the spikelet; lemma like the upper glume.

Leaf Anatomy.—Keel absent. Abaxial surface undulated. Adaxial surface prominently ribbed with flat-topped ribs; ribs opposite first-order bundles broader; furrows between ribs narrow. Parenchyma absent. Bundles of first order girdered, with outer bundle-sheath often more or less interrupted by abaxial stereome strands; second-order bundles triangular in outline; third-order bundles developed opposite motor cells. Chlorophyll tissue forming masses of radiating cells round bundles. Motor cells distinct between ribs, with central cell broader than deep. Adaxial epidermis opposite bundles consisting of rows of cells composed of groups

of 2 short cells alternating with long cells; stomata in 1–3 rows between ribs (*S. Tysonii* Stent, Bothalia, ii, 1*b*, 262, 1927).

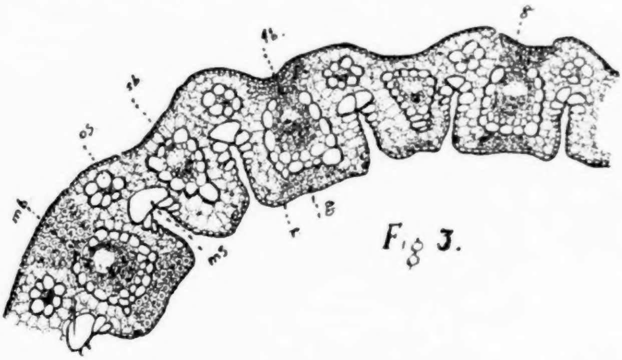


Fig 3.

Cape Province.—Griqualand East, near Kokstad, *Tyson* 1473 (*Herb. Mus. Austr. Afr.*). Cathcart, between Windvogelberg and Swart Kei River, *Drège* (*Kew Herb.*).

var. **laxivaginatus** (Stent), comb. nov. (fig. 4).

Adaxial keel region distinct; parenchyma distinct in keel region (*S. laxivaginatus* Stent, Bothalia, ii, 1*b*, 262, 1927).

Transvaal.—Between Machadodorp and Carolina, *Mundy* (*Nat. Herb. Pret.*, H. 4286). Tzaneen, New Agatha, *McCallum* (*Nat. Herb. Pret.*, H. 21682).

Natal.—Bergville, Mt. Aux Sources, *MacClean* and *Bayer* 178 (*Herb. Alb. Mus.*). Ladysmith, Van Reenen, *Wood* 7218; *Phillips* 2301 (*Nat. Herb. Pret.*). Umpumulo, on the hills, *Buchanan* 64 and 297 (*Nat. Herb. Pret.*). Pietermaritzburg, Cedara, *Fisher* 44 (*Nat. Herb. Pret.*).

Cape Province.—Kokstad, *Mogg* 5063 (*Nat. Herb. Pret.*). Griqualand East, *Tyson* 1372 (*Herb. Austr. Afr. Mus.*). Bazeia, *Baur* 555 (*Herb. Alb. Mus.*). Keiskama Hoek, *Dyer* 259, 261, 796 (all in *Alb. Mus. Herb.*). Hogsback, *Rattray* 281 and 445 (*Alb. Mus. Herb.*).

var. **filifolius** (Stent), comb. nov. (fig. 5, A–B).

Basal leaves very narrow; adaxial keel region distinct; parenchyma distinct in keel region; motor cells apparently absent (*S. filifolius* Stent in Bothalia, ii, 1*b*, 260, 1927).

Natal.—Strydhoek, Tintwe, *Doidge* (*Nat. Herb. Pret.* 19813).

Cape Province.—Kokstad, Mt. Currey, *Goossens* 287 (*Nat. Herb. Pret.*). Uitenhage, Van Stadensrivier Mountains, *Ecklon* and *Zeyher* 289 (*Herb. Mus. Austr. Afr.*). Hoffmans Bosch, *Britten* 1145 (*Alb. Mus. Herb.*).

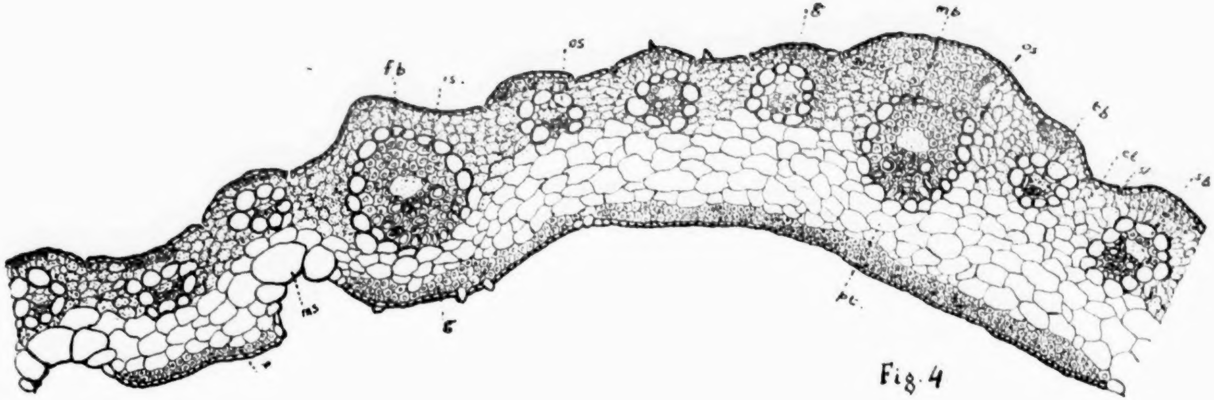


Fig. 4

Basutoland.—Leribe, *Dieterlen* 6328 (*Herb. Mus. Austr. Afr.*); 671 (*Nat. Herb. Pret.*).

The plants of *S. Tysonii* Stent, *loc. cit.*, are referable to *S. centrifugus* Nees, for anatomically they agree exactly with Drège's plant from the

Fig. 5.

Windvogelberg on which Nees has based his species. Schweikerdt (Kew Bull., 209 (1935)) considers Miss Stent's *S. laxivaginatus* synonymous with *S. centrifugus* Nees, but anatomically they differ in the points mentioned, and I feel justified in retaining it as a variety of *S. centrifugus* Nees.

3. **S. Schlechteri** Schweikerdt in Kew Bull., 208 (1935) (figs. 6 and 6*a*).

Perennial; culms slender, erect, glabrous, up to 37 cm. high; blades flat or involute, 4–10 cm. long, 2–3 mm. wide; panicle narrow ovate, branches whorled; spikelets olive-brown, slightly over 3 mm. long; lower

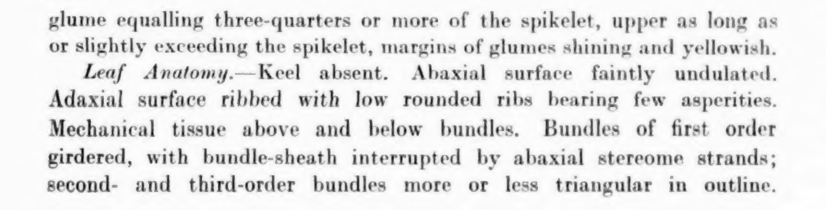
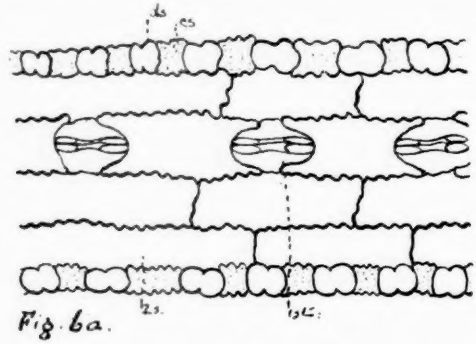


Fig. 6.

glume equalling three-quarters or more of the spikelet, upper as long as or slightly exceeding the spikelet, margins of glumes shining and yellowish.

Leaf Anatomy.—Keel absent. Abaxial surface faintly undulated. Adaxial surface ribbed with low rounded ribs bearing few asperities. Mechanical tissue above and below bundles. Bundles of first order girdered, with bundle-sheath interrupted by abaxial stereome strands; second- and third-order bundles more or less triangular in outline.

Parenchyma absent. Chlorophyll tissue forming masses of radiating cells round bundles. Motor cells distinct in the furrows between ribs, with central cells as broad as deep. Abaxial epidermis opposite bundles



consisting of rows of short cells alternating with rows of long cells; stomata in 1 or 2 rows in region between bundles.

TRANSVAAL.—Lydenburg, *Schlechter* 3965 (*Herb. Alb. Mus.* and *Nat. Herb. Pret.*).

BASUTOLAND.—Leribe, *Dieterlen* 671 *ex parte* (*Herb. Mus. Austr. Afr.*).

Drège's specimen from Gekau and Bashee is very poor, but is apparently similar to *S. Schlechteri.* I have not seen Richardson's specimen from Bethlehem, which Schweickerdt includes under his species.

4. **S. pectinatus** Hack. in Oestr. Bot. Zeitschr., liii, 198 (fig. 7).

Perennial; culms slender to subrobust, erect, glabrous; blades mostly basal, flat or folded, pectinate ciliate, up to 12 cm. long, 6 mm. wide; panicle ovate, open or somewhat contracted, up to 17 cm. long and 8 cm. broad, lowest internode about 3 cm. long, branches whorled; spikelets dark brownish green, about 3 mm. long; lower glume equalling half the spikelet, the upper equalling the spikelet; lemma like the upper glume.

Leaf Anatomy.—Keel and midrib ill-defined. Abaxial surface with undulating ribs. Adaxial surface distinctly ribbed; ribs usually flat-topped with deep furrows between them. Mechanical tissue above and below bundles. Parenchyma absent. Bundles not girdered, with the bundle-sheath continuous. Chlorophyll tissue forming masses of radiating cells round bundles. Motor cells large, as broad as, or broader than deep. Adaxial epidermis opposite bundles consisting of groups of short cells alternating with long cells; stomata in 1 or 2 rows between ribs.

TRANSVAAL.—Pretoria, Derdepoort, *Fouché* (*Nat. Herb. Pret.*);

Koedoesrand, *Smith* 1560; Sunnyside, *Mogg* 15997; Onderstepoort,

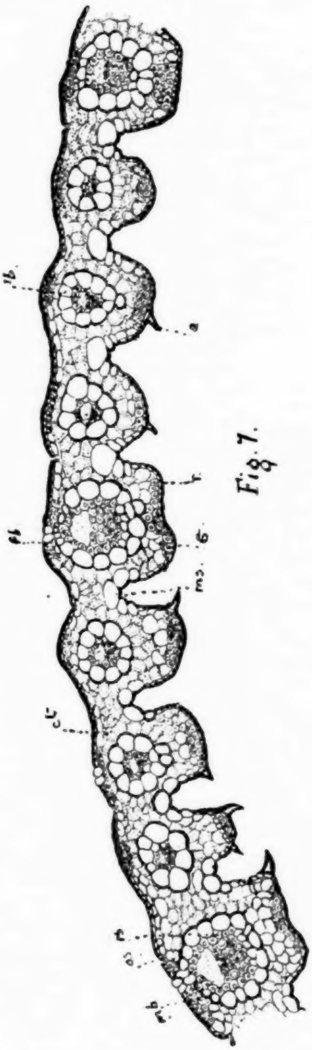


Fig. 7.

Mogg 7824; Irené, *Pole Evans* 367 (all in *Nat. Herb. Pret.*). Johannesburg, *Paterson* (*Alb. Mus. Herb.*); *Rogers* 1396 (*Alb. Mus. Herb.*); *Hutton* 253

(co-type in *Alb. Mus. Herb.*); *Burtt-Davy* 18887 (*Kew Herb.*); Benoni, *Bradfield* 301 (*Nat. Herb. Pret.*). Carolina, Leeuwpoort, *Burtt-Davy* 2990 and 7736 (*Nat. Herb. Pret.*). Middelburg, *Fouché* (*Nat. Herb. Pret.* 21015). Zoutpansberg, Downs, *Junod* (*Nat. Herb. Pret.*). Ventersdorp, *Sutton* 540 (*Nat. Herb. Pret.*).

Cape Province.—George, Christiana Bay, *Schlechter* 2453 (*Alb. Mus. Herb.* and *Herb. Mus. Austr. Afr.*).

This species is very distinct and easily recognisable by the prominent pectinate hairs on the margins of the leaf. Anatomically it comes near *S. Schlechteri* Schweikerdt, from which it differs in the nature of the epidermis. According to Miss Stent (Bothalia, ii, 1*b*, 260), Hackel places it near *S. iocladus* Nees, but in their anatomy they show very little affinity. Miss Stent, *loc. cit.*, erroneously includes *Schlechter* 3965 both under this species and under *S. centrifugus.*

5. **S. Conrathii** Chiov. in Ann. Bot. Roma, xiii, 49, 1914 (fig. 8).

Perennial; culms slender, erect, up to 49 cm. long; blades very narrow, flat or setaceously convolute, up to 12 cm. long, about 1 mm. wide; panicle ovate, open, lax, with fine white hairs in the axils of the branches, 8–15 cm. long, 4–10 cm. broad, branches solitary or binate, spreading at right angles; spikelets dark greyish green, 1·6 mm. long; glumes subequal, equalling about one-third of the spikelet.

Leaf Anatomy.—Keel indistinct. Abaxial surface with ill-defined undulating ribs. Adaxial surface with 3 low ribs and 2 large marginal structures. Parenchyma absent. Bundles of first order girdered and their outer bundle-sheath interrupted by abaxial stereome strands. Chlorophyll tissue forming definite masses of radiating cells round bundles. Motor cells distinct, in four groups, more or less bean-shaped, deeper than broad. Abaxial epidermis opposite bundles consisting of groups of 2 short cells alternating with long cells; stomata in 1 or 2 rows between ribs.

Transvaal.—Rustenburg, near Crocodile River, *Schlechter* 3977 (co-type in *Alb. Mus. Herb.*). Pretoria, Rooikop, *Pole Evans* 535 (*Nat. Herb. Pret.*); Premier Mine, *Menzies* 16 (*Nat. Herb. Pret.*).

Orange Free State.—Heilbron, Maccauvlei, *Brandmuller* 36 (*Nat. Herb. Pret.*).

The specific name *S. micranthus* Conrath and Hack. in Oestr. Bot. Zeitschr., 198 (1903), as used by Miss Stent (Bothalia, ii, 1*b*, 266), has previously (1895) been used by Durand and Schinz for an Abyssinian plant. In 1914 Chiovendi, *loc. cit.*, proposed the name *S. Conrathii* for the species of Conrath and Hackel.

Fig 8.

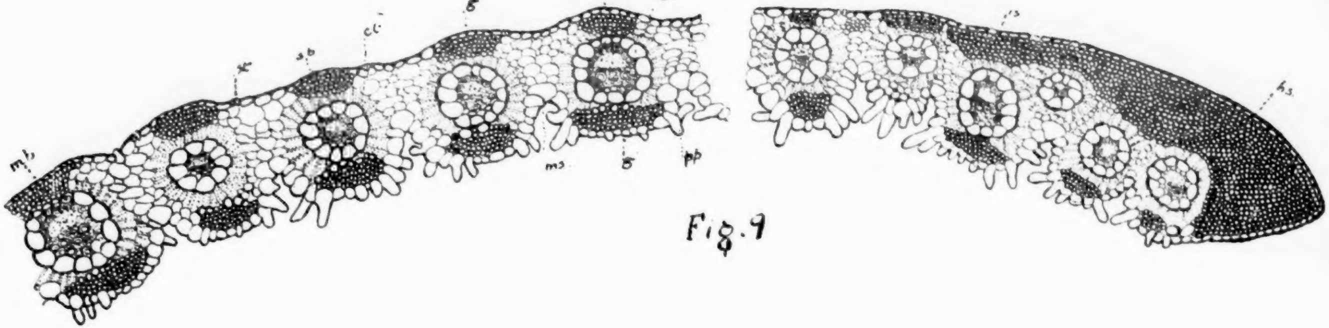


Fig. 9

6. **S. acinifolius** Stapf in Dyer, Fl. Cap., vii, 581 (fig. 9).

Perennial; culms erect, slender, 23–35 cm. long; blades subulate, flat, 2·5 cm. long, 3 mm. wide; panicle ovate, very lax, 6·5–12 cm. long, 5–6·5 cm. broad; spikelets oblong, purplish, 1·6 mm. long; lower glume 1 mm. long, upper 1·5 mm. long.

Leaf Anatomy.—Keel absent. Abaxial surface shallowly ribbed. Adaxial surface with low rounded ribs; asperities on ribs. Parenchyma absent. First-order bundles girdered. Chlorophyll tissue in masses of radiating cells round bundles; masses usually separated by strands of clear cells extending from motor cells to abaxial epidermis. Motor cells in groups of 3–5, with the central cell large and more or less as broad as deep. Abaxial epidermis opposite bundles consisting of rows of cells composed of groups of 2 short cells alternating with long cells; stomata in 2 rows between ribs. Margins with strongly developed mechanical tissue which is continuous with the abaxial stereome strands of the last 3 or 4 bundles.

Cape Province.—Kuruman, *Mogg* 7635 (*Nat. Herb. Pret.*). Vryburg, *Foley*; *Henrici* 174; *Rodger* (all in *Nat. Herb. Pret.*). Griquatown, *Burchell* 1846 (*Kew Herb.*).

7. **S. Fourcadii** Stent in Bothalia, ii, 1*b*, 269 (figs. 10 and 10*a*).

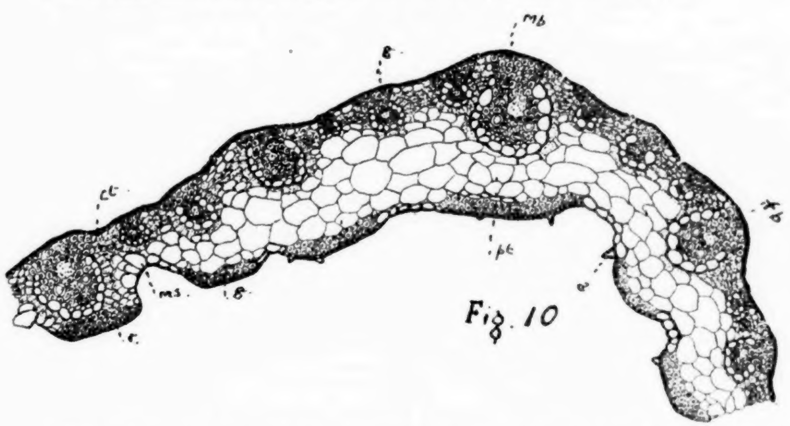


Fig. 10

Perennial; culms more or less erect, 14–40 cm. long, 1-noded; blades flat or involute, 8–10 cm. long, about 4 mm. wide; panicle narrow, scanty, branches solitary, spreading; spikelets subsessile, greyish green, 2 mm. long; lower glume quarter to one-third the length of the spikelet, upper about two-thirds the length of the spikelet.

Leaf Anatomy.—Keel more or less distinct. Abaxial surface indistinctly ribbed. Adaxial surface ribbed with low ribs; ribs opposite first-order bundles outside keel region broad and flat-topped. Mechanical tissue above and below bundles. Parenchyma developed in keel region. Bundles of first order outside keel region girdered; third-order bundles developed opposite motor cells; outer bundle-sheath of all first-order bundles and all bundles in keel region interrupted by abaxial stereome

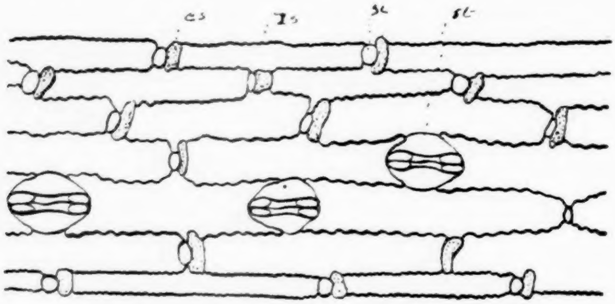


Fig. 10a.

strands. Chlorophyll tissue forming masses of radiating cells round bundles. Motor cells indistinct in keel region, but distinct between ribs outside keel region. Abaxial epidermis opposite bundles consisting of rows of cells composed of groups of 2 short cells alternating with long cells; stomata in 2 or 3 rows in region between bundles.

Cape Province.—Humansdorp, *Fourcade* 1986 (type in *Nat. Herb. Pret.*). George, *Schlechter* 2224 (*Alb. Mus. Herb.*). Bathurst, Kowie, *Hutton* 45 (*Alb. Mus. Herb.*).

8. **S. Sladenianus** Bolus in Ann. S. Afr. Mus., ix, 236 (figs. 11 and 11*a*).

Perennial; culms erect or ascending, up to 20 cm. long; blades tapering to a fine point, flat or setaceously convolute, 2·5–5 cm. long, 0·1–0·25 cm. broad; panicle oval, 7·5–15 cm. long, 5 cm. broad; spikelets olive-grey, 1·5–1·7 mm. long; glumes subequal; the lower about two-thirds of the spikelet, upper slightly shorter than the spikelet, 1-nerved.

Leaf Anatomy.—Keel poorly developed. Abaxial surface with ill-defined undulating ribs. Adaxial surface shallowly ribbed, with the ribs opposite lateral first-order bundles flat-topped, and rounded opposite other bundles outside keel region. Parenchyma poorly developed in keel region. Bundles of first-order interrupted above and below by

stereome strands. Motor cells distinct between each rib, with the central cell as broad as deep. Chlorophyll tissue not forming masses of radiating cells round bundles. Abaxial epidermis opposite bundles

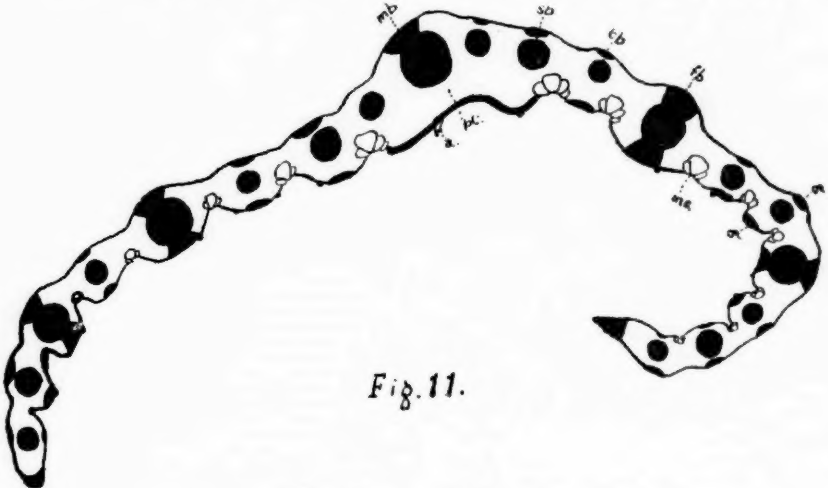


Fig. 11.

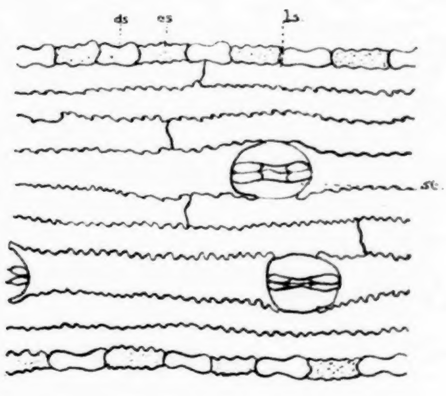


Fig. 11a.

consisting of rows of short cells alternating with rows of long cells; stomata in 2 rows between ribs.

NAMAQUALAND.—Schakkalskuppe, *Pearson* 477 (part of type in *Nat. Herb. Pret.*).

This species is not included in Miss Stent's monograph. A cross-section of its leaf agrees remarkably well with that of *S. Fourcadii* Stent, but differs from it in the organisation of the epidermal cells.

9. **S. tenellus** Kunth in Enum., i, 215 (fig. 12).

Perennial, with a much-branched rhizome; culms erect or ascending, very slender, 1-noded, 4–15 cm. long; blades ovate to linear, flat or folded, 3–8 mm. long, 1–2·5 mm. wide; panicle ovate, lax, 2·5–4 cm. long, branches solitary; spikelets pallid or purplish with yellow tips, up to 1·8 mm. long; lower glume equalling less than half the spikelet, upper rather more than half the spikelet.

Leaf Anatomy.—Keel absent. Abaxial surface slightly ribbed, with

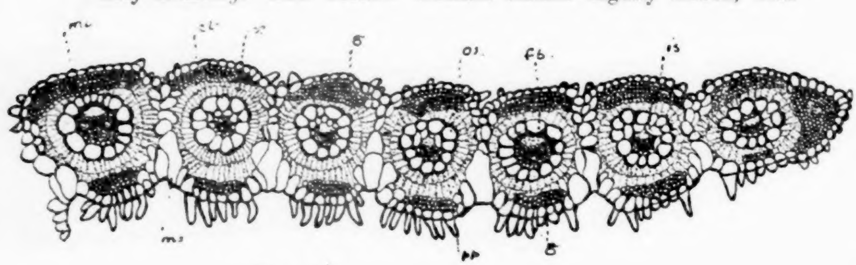


Fig 12

occasional asperities. Adaxial surface ribbed with shallow ribs bearing asperities. Mechanical tissue above and below bundles and in margins. Parenchyma absent. Bundles with uninterrupted bundle-sheath. Chlorophyll tissue in definite masses of radiating cells round bundles, separated by strands of clear cells extending from motor cells to abaxial epidermis. Motor cells at base of each rib, more or less deeper than broad. Abaxial epidermis opposite bundles consisting of rows of short cells alternating with rows of long cells; stomata in 1 or 2 rows between ribs.

Cape Province.—Beaufort West, *Zeyher* (*Alb. Mus. Herb.*). Middelburg, *Sim* 2701 (*Alb. Mus. Herb.*). Oudtshoorn, *Britten* 1749 (*Alb. Mus. Herb.*). Cradock, *Dyer* 1028 (*Nat. Herb. Pret.*). Victoria West, Hutchinson, *Burtt-Davy* 17591 (*Nat. Herb. Pret.*).

Orange Free State.—Fauresmith, *Smith* 3889, 4347a (*Nat. Herb. Pret.*). Brandfort, *Naudé* 2892 (*Kew Herb.*).

10. **S. albicans** Nees in Fl. Afr. Austr., 154 (fig. 13).

Perennial; culms erect, sheathed almost all along, 3–15 cm. long; blades involute, up to 1·2 cm. long, up to 1 mm. wide; panicle ovate,

3–5 cm. long, 2·5–3 cm. broad, branches solitary; spikelets slightly over 2 mm. long; lower glume about half the spikelet, upper slightly shorter than the spikelet.

Leaf Anatomy.—Keel absent. Abaxial surface smooth or faintly undulated. Adaxial surface ribbed with low rounded ribs bearing papillæ. Parenchyma absent. Bundles of first order more or less girdered, with

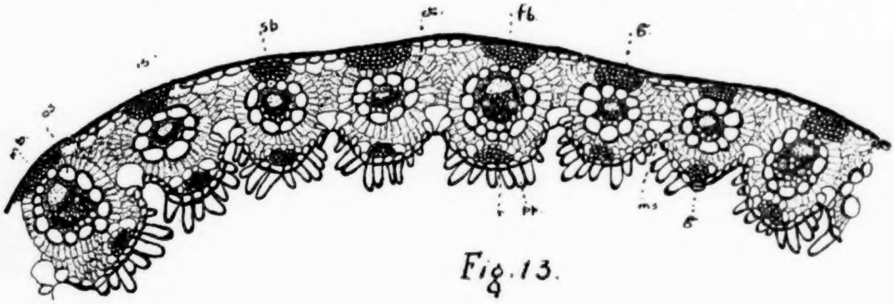


Fig. 13.

bundle-sheath continuous. Chlorophyll tissue forming masses of radiating cells round bundles. Motor cells at base of each rib, with central cell as broad as deep. Abaxial epidermis opposite bundles consisting of rows of short cells alternating with rows of long cells; stomata in 2 rows in region between bundles.

Cape Province.—Between Table Mountain and Wildschutsberg, *Drège* (*Herb. Mus. Austr. Afr.*).

Miss Stent has not included this species in her monograph.

11. **S. festivus** var. **fibrosus** Stapf in Cheval. Sudan., 142, 155 (1911) (fig. 14).

Perennial; culms erect, slender, 15–30 cm. long; blades flat or involute, 2–6 cm. long, 2–4 mm. broad; panicle ovate, up to 10 cm. long, 2·5–4 mm. broad, branches solitary or irregularly fascicled; spikelets 1–1·3 mm. long, purplish; glumes subequal, 0·3–0·5 mm. long.

Leaf Anatomy.—Keel absent. Abaxial surface of leaf smooth or faintly undulated. Adaxial surface slightly ribbed with low rounded ribs, bearing occasional minute asperities. Mechanical tissue above and below bundles. Bundles more or less triangular in outline; outer bundle-sheath not interrupted. Chlorophyll tissue forming masses of radiating cells round bundles, often separated between bundles by strings of clear cells extending from motor cells to abaxial surface. Motor cells distinct between ribs, with central cell large and extending half-way through leaf to abaxial surface. Abaxial epidermis opposite bundles consisting of

rows of short cells alternating with rows of long cells; stomata in 2 rows in region between bundles.

TRANSVAAL.—Zoutpansberg, Houtbosch, *Schlechter* 4403 (*Alb. Mus. Herb.*). Waterberg, Pienaars River, *Schlechter* 4207, 6355 (*Alb. Mus. Herb.*, *Nat. Herb. Pret.*, and *Trans. Mus. Herb.*); Warmbad, *Stent* H. 21536

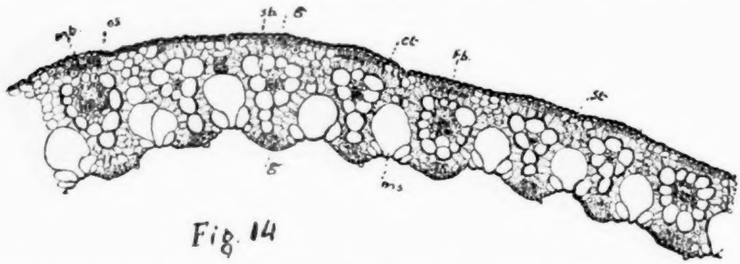


Fig. 14

(*Nat. Herb. Pret.*); Springbok Flats, *Burtt-Davy* 1111 (*Nat. Herb. Pret.*). Potgietersrust, *Leendertz* 6590 (*Trans. Mus. Herb.*); *Galpin* 8907 (*Nat. Herb. Pret.*). Pretoria, Klapperkop, *Skea* 56 (*Nat. Herb. Pret.*). Johannesburg, *Edwards* 274 (*Alb. Mus. Herb.*). Ventersdorp, *Sutton* 563 (*Nat. Herb. Pret.*). Geelhoutkop, *Beyer* 21455 (*Trans. Mus. Herb.*).

This variety is not included by Stapf in Dyer, Fl. Cap., vii, but only the closely related *S. festivus* var. *stuppeus* Stapf, to which Stent (Bothalia, ii, 1*b*, 264) has given specific rank.

var. **stuppeus** Stapf in Dyer, Fl. Cap., vii, 582 (fig. 14).

Anatomically identical with var. *fibrosus* Stapf, from which it differs in that the basal sheaths split up readily, forming dense mats.

TRANSVAAL.—Johannesburg, *Burtt-Davy* 7496 (*Nat. Herb. Pret.*). Pretoria, *Leendertz* 6286 (*Trans. Mus. Herb.*); Irené, *Burtt-Davy* 14656; *Pole Evans* 21223; Sunnyside, *Mogg* 15994; Ashbury Station, *Smith* 1324; Magaliesberg, near Wonderboom, *Burtt-Davy* 2683, 3343, 7148; *Pole Evans*; Kaalplaats, *Mogg* 340 (all in *Nat. Herb. Pret.*); Magaliesberg, *Schlechter* 3595 (*Alb. Mus. Herb.*), 6364 (*Trans. Mus. Herb.*); Rietfontein, *Pole Evans* (*Nat. Herb. Pret.*); *Theiler* 26677 (*Trans. Mus. Herb.*). Rustenburg, Rooikop, *Pole Evans* 256 (*Nat. Herb. Pret.*); Pillansberg, *Smuts* and *Pole Evans* 632; Crocodile River, *Schlechter* 3900 (*Alb. Mus. Herb.* and *Herb. Mus. Austr. Afr.*). Waterberg, Nylstroom, *Burtt-Davy* 2023, 2068 (*Nat. Herb. Pret.*); Klipfontein, Springbok Flats, *Nelson* 274 (*Trans. Mus. Herb.*). Barberton, *Williams* 6266 (*Trans. Mus. Herb.*); *Matthews* 46 (*Nat. Herb. Pret.*); *Pott* 26676 (*Trans. Mus. Herb.*). Zoutpansberg, *Obermeyer* 29337 (*Trans. Mus. Herb.*). Nelspruit, *Liebenberg* 2822 (*Nat. Herb. Pret.*).

Swaziland.—Black M'belusi, *Burtt-Davy* 10650 (*Nat. Herb. Pret.*).

Natal.—Dundee, *Green* 81 (*Natal Herb.*). Camperdown, *Franks* (*Natal Herb.*). Maritzburg, *St George* 25 (*Natal Herb.*). Howick, *Franks* (*Natal Herb.*). Alexandra, *Rudatis* 758 (*Nat. Herb. Pret.*).

Except perhaps for the size of the glumes, I fail to see that the characters given by Miss Stent (Bothalia, ii, 1*b*, 264) are so important and reliable as to give Stapf's variety, *loc. cit.*, specific rank. Anatomically I find no difference between it and *S. festivus* var. *fibrosus* Stapf, and I am inclined to support Stapf in considering it merely as a variety of *S. festivus* Hochst.

12. **S. nitens** Stent in Bothalia, i, 281, 1927 (fig. 15).

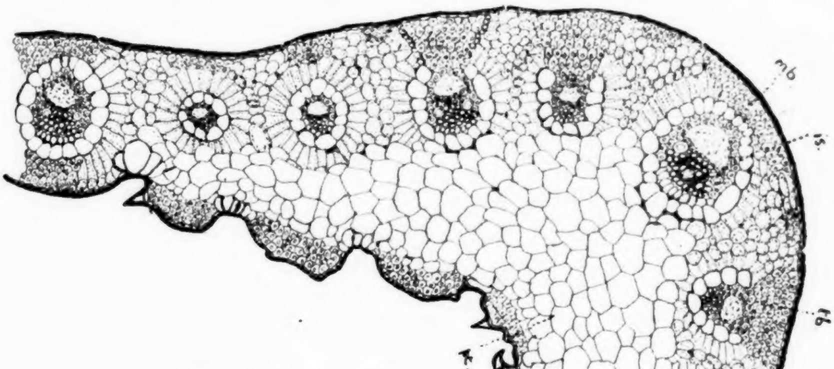


Fig. 15.

Perennial; culms erect or prostrate ascending, compressed below, sheathed almost to base of panicle, 13–30 cm. long; blades flat, 6 cm. long, about 7 mm. wide; panicle ovate to lanceolate, 6–10 cm. long, 2·5–4 cm. broad, lowest branches whorled and the others solitary or paired; spikelets dark grey, 1·5 mm. long; lower glume about half the spikelet, upper equalling or slightly exceeding the spikelet.

Leaf Anatomy.—Keel prominent, rounded. Abaxial surface smooth or with slightly undulating ribs. Adaxial surface distinctly ribbed (even in keel region) with the ribs opposite lateral first-order bundles flat-topped. Parenchyma prominent in keel region. Lateral first-order bundles girdered. Bundle-sheath of bundles in keel region usually interrupted by abaxial stereome strands. Chlorophyll tissue forming masses of radiating cells round bundles. Motor cells distinct, with central cell large and as broad as deep. Abaxial epidermis opposite bundles consisting of rows of cells composed of groups of 2 short cells alternating with long cells, or occasionally with rows of short cells alternating with rows of long cells; stomata in 2 rows between ill-defined ribs. Margins undulated and spinulous ciliate.

TRANSVAAL.—Pretoria, Magaliesberg, *Schlechter* 3679; Rooikop, *Pole Evans* 667; Gezina, *Fouché* and *Stent* 21445; Pretoria, *Mogg* 14849; Onderstepoort, *Mogg* 7825; Prinshof, *Liebenberg* 3193 (all in *Nat. Herb. Pret.*). Nylstroom, . . . ? 691 (*Nat. Herb. Pret.*). Zeerust, *Liebenberg* S. 32 (*Nat. Herb. Pret.*).

CAPE PROVINCE.—Albany, Koonap Flats, *Schonland* 3705 (*Nat. Herb. Pret.* and *Alb. Mus. Herb.*); Albany, *Linstedt* 1 (*Nat. Herb. Pret.*); Fish River Valley, *Dyer* 2171 (*Alb. Mus. Herb.*).

Anatomically this species is closely related to *S. Smutsii* Stent, *S. usitatus* Stent, and *S. iocladus* Nees, but differs from them in its external morphological features.

13. **S. iocladus** Nees in Fl. Afr. Austr., 161 (fig. 16).

Tufted perennial; culms erect or geniculate, slender, 30–60 cm. long; blades flat or convolute, 3–17 cm. long, 2–4 mm. wide; panicle ovate to ovate lanceolate, 9–13 cm. long, up to 8 cm. broad, lowest branches whorled; spikelets dark greyish green, 1·5–2 mm. long; lower glume small, equalling about one-third of spikelet, upper more or less as long as the spikelet; lemma equalling the upper glume.

Leaf Anatomy.—Keel prominent, rounded. Abaxial surface with ill-defined undulating ribs. Adaxial surface with shallow ribs outside keel region, with the ribs opposite the lateral first-order bundles flat-topped. Lateral first-order bundles girdered. Outer bundle-sheath of bundles in keel region usually interrupted by abaxial stereome strands. Chlorophyll tissue forming masses of radiating cells round bundles. Motor cells in

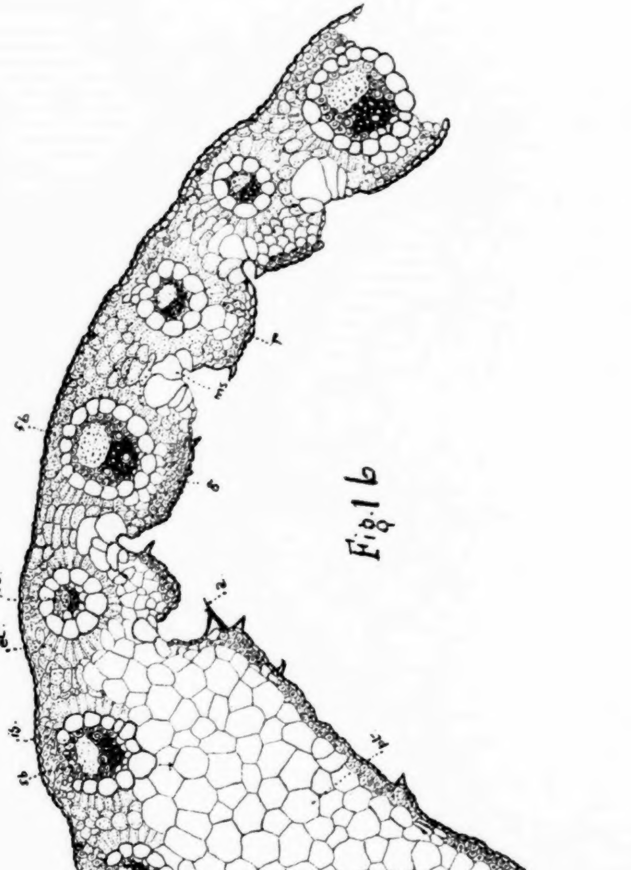


Fig. 1 b

groups of 3–5, with the central cell large and usually as broad as deep. Abaxial epidermis opposite bundles consisting of rows of cells composed of groups of 2 short cells alternating with long cells, or of rows of short cells alternating with rows of long cells; stomata in 2 rows in region between bundles. Margins minutely pectinate ciliate (*S. Gillii* Stent in Bothalia, ii, 1*b*, 256; *S. Vryburgensis* Stent, Bothalia, ii, 1*b*, 254).

Orange Free State.—Fauresmith, Groenvlei, *Smith* 3888 (*Nat. Herb. Pret.*).

Cape Province.—Middelburg, Grootfontein, *Gill* 7 and 31 (*Nat. Herb. Pret.*). Uitenhage, Steenbokvlakte, *Ecklon* and *Zeyher* (*Alb. Mus. Herb.* and *Herb. Mus. Austr. Afr.*). Graaff-Reinet, Klipfontein, *Burtt-Davy* 13526 (*Nat. Herb. Pret.*). Hanover, *Sim* 6262 (*Nat. Herb. Pret.*). Albany, *Linstedt* 35 and 37 (*Nat. Herb. Pret.*). Somerset East, Biesjesfontein, near Lootskloof, *MacOwen* 1609 (*Alb. Mus. Herb.*).

Transvaal.—Bloemhof, on the banks of the Vaal River, *Burtt-Davy* 1507 (*Nat. Herb. Pret.*).

Miss Stent, *loc. cit.*, states that her *S. Gillii* is near *S. iocladus* Nees, differing from it in the short basal sheaths, the shorter panicle, and the more obtuse spikelets. It must be admitted that such characters are indistinct, very variable, and therefore unreliable to found a new species on. She also erroneously states that they differ anatomically.

Furthermore, the difference between her *S. Vryburgensis* and *S. iocladus* Nees is so slight and their anatomy is so alike, that to my mind there is no justification in separating them. Both her species appear to be merely ecological variations of *S. iocladus* Nees, and they are therefore referred to the latter.

S. iocladus Nees is anatomically closely related to *S. nitens* Stent, but the adaxial surface in the keel region is without prominent ribs.

14. **S. Smutsii** Stent in Bothalia, i, 281, 1927 (fig. 17).

Anatomically and morphologically near to *S. iocladus* Nees, from which it differs in being stoloniferous.

Transvaal.—Waterberg, Naboomspruit, *Galpin* M. 682 and M. 704; Leeuwkraal, *Pole Evans* 668. Barberton, Komatipoort, *Pole Evans* 13034; Warmbad, *Pole Evans*. Pretoria, Rooikop, *Pole Evans* 271, 536, 556, 590 (all in *Nat. Herb. Pret.*).

var. **longifolius** Goossens in Kew Bull., 197 (1934).

Internodes of stolons long; leaves over 8 cm. long. Anatomically like species.

Transvaal.—Zoutpansberg, Messina, *Pole Evans* 2629 (*Nat. Herb. Pret.*).

Zululand.—Magut, *Goossens* 609 (*Nat. Herb. Pret.*).

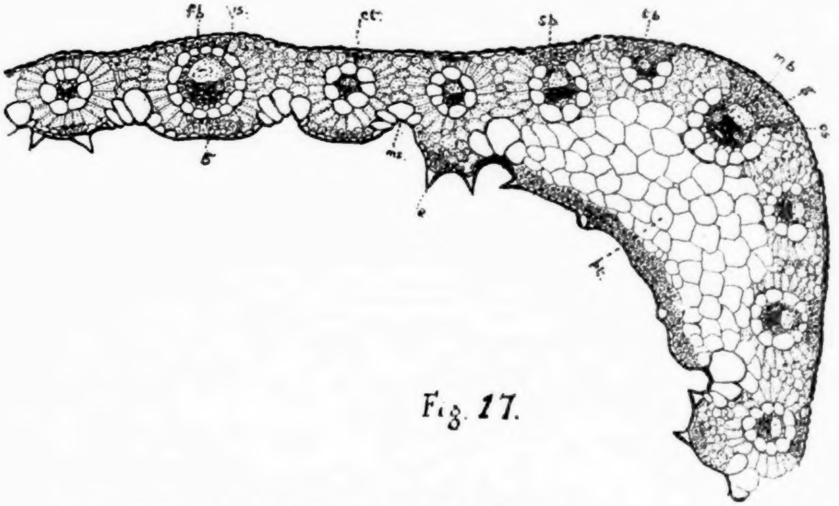


Fig. 17.

15. **S. usitatus** Stent in Bothalia, ii, 1*b*, 257, 1927 (fig. 18).

Perennial, stoloniferous; culms geniculate, often prostrate, ascending, 30–45 cm. long; blades up to 8 cm. long, about 4 mm. wide; panicle ovate acuminate, up to 9 cm. long, 4–5 cm. broad, branches usually whorled; spikelets on short appressed pedicels, 2–2·3 mm. long, greyish green; lower glume less than half the spikelet, upper the size of the spikelet.

Anatomy of leaf like that of *S. Smutsii* Stent, from which it differs in that the leaf margins are not pectinate ciliate.

TRANSVAAL.—Pretoria, Meintjeskop, *Stent* H. 21624 (type in *Nat. Herb. Pret.*). Potchefstroom, *Burtt-Davy* 847*a* (*Nat. Herb. Pret.*).

ORANGE FREE STATE.—Kroonstad, *Goossens* 1236 (*Herb. P.U.C.*). Senekal, *Goossens* 1012 (*Herb. P.U.C.*).

CAPE PROVINCE.—Vryburg, Elmar, *Burtt-Davy* 14056*a* (*Nat. Herb. Pret.*).

Miss Stent, *loc. cit.*, does not consider this a distinctive species and thinks it is closely related to *S. Ludwigii* Hochst., but in their leaf anatomy they differ remarkably. This probably explains why she has included the two specimens, *Burtt-Davy* 847*a* and 14056*a*, which are anatomically identical with the type, under *S. usitatus* Stent.

16. **S. Ludwigii** Hochst. in Flora, 118 (1846) (fig. 19).

Perennial with creeping rhizome; culms very slender, 13–30 cm. long; blades flat, 1–3 cm. long, 2–3 mm. wide; panicle ovate, lax, 3–8 cm. long,

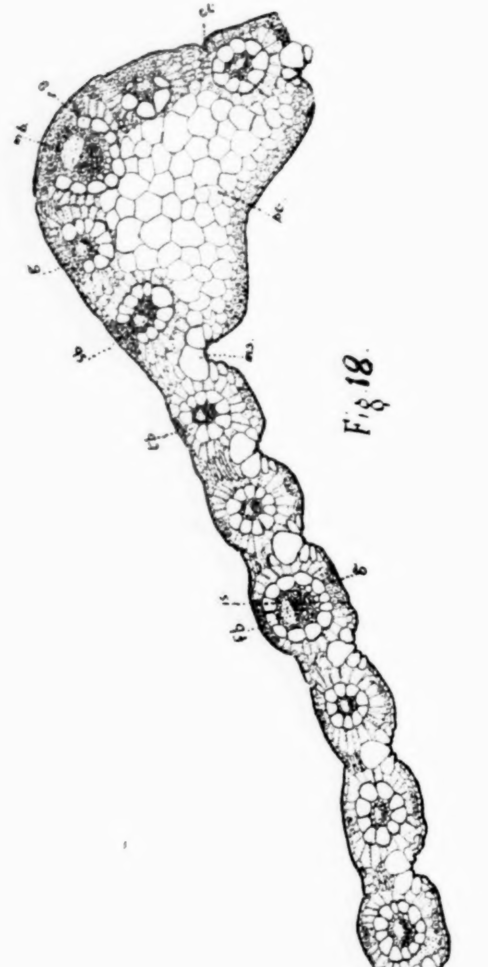


Fig 18.

2-5 cm. broad, lowest branches whorled; spikelets close, dark olive-green, 1·5–2 mm. long; lower glume 0·5 mm. long, upper 1·5–2 mm. long.

Leaf Anatomy.—Keel absent. Abaxial surface slightly ribbed, with occasional asperities. Adaxial surface ribbed with shallow ribs bearing asperities. Mechanical tissue above and below bundles and in margins. Parenchyma absent. Bundle-sheaths uninterrupted. Chlorophyll tissue in definite masses of radiating cells round bundles, separated by strands of clear cells extending from motor cells to abaxial epidermis. Motor cells at base of each rib, more or less deeper than broad. Abaxial epidermis opposite bundles consisting of rows of short cells alternating with rows of long cells; stomata in 1 or 2 rows between ribs.

Cape Province.—Graaff-Reinet, on stony hills at Sunday River, *Drège* (*Herb. Mus. Austr. Afr.*). Vryburg, *Foley* 2826 (*Nat. Herb. Pret.*).

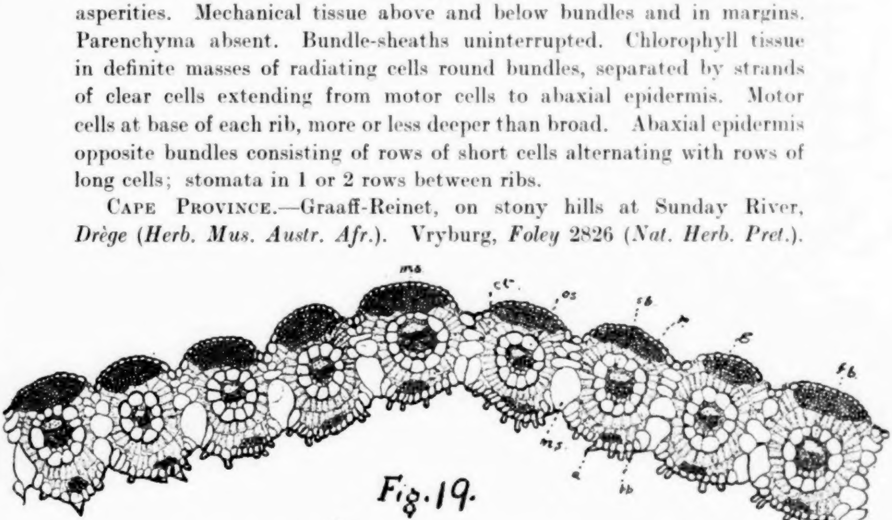


Fig. 19.

Middelburg, *Gill* 43 (*Nat. Herb. Pret.*). Griqualand West, du Toits Pan, *Tuck* (*Herb. Mus. Austr. Afr.*). Without precise locality, *Drège* 9842 (*Nat. Herb. Pret.*).

Orange Free State.—Boshof, Beth-el-Pella, *Wolff* 30 (*Nat. Herb. Pret.*); Smitskraal, *Burtt-Davy* 10125, 12950 (*Nat. Herb. Pret.*). Fauresmith, Bakbank, *Smith* 4034 (*Kew Herb.*).

Transvaal.—Bloemhof, Christiana, *Burtt-Davy* 12498, 12809 (*Nat. Herb. Pret.*).

According to Miss Stent (Bothalia, ii, 1*b*, 257) her *S. usitatus* comes near to *S. Ludwigii*. This may be so as far as the external characters are concerned, but in their leaf anatomy they differ widely. This also explains why she has erroneously included *Burtt-Davy* 847*a* from Potchefstroom and *Burtt-Davy* 14056*a* from Vryburg under the latter species.

17. **S. robustus** Kunth in Rev. Gram., ii, 425, t. 126 (fig. 20).

Perennial; culms robust, geniculate, ascending, up to 6-noded; blades flat or folded, up to 26 cm. long, 4–6 mm. wide; panicle long, narrow, 23–42 cm. long, 1·5–5·5 cm. broad, lowest branches usually subwhorled;

spikelets pale greyish green, 2·5 mm. long; glumes equal or subequal, the length of the spikelet, scabrid; lemma like glumes but not scabrid.

Leaf Anatomy.—Keel more or less distinct. Abaxial surface indistinctly undulated. Adaxial surface outside keel region ribbed with low ribs bearing few asperities. Mechanical tissue above and below bundles. Parenchyma prominent in keel region. Bundles in keel region (often

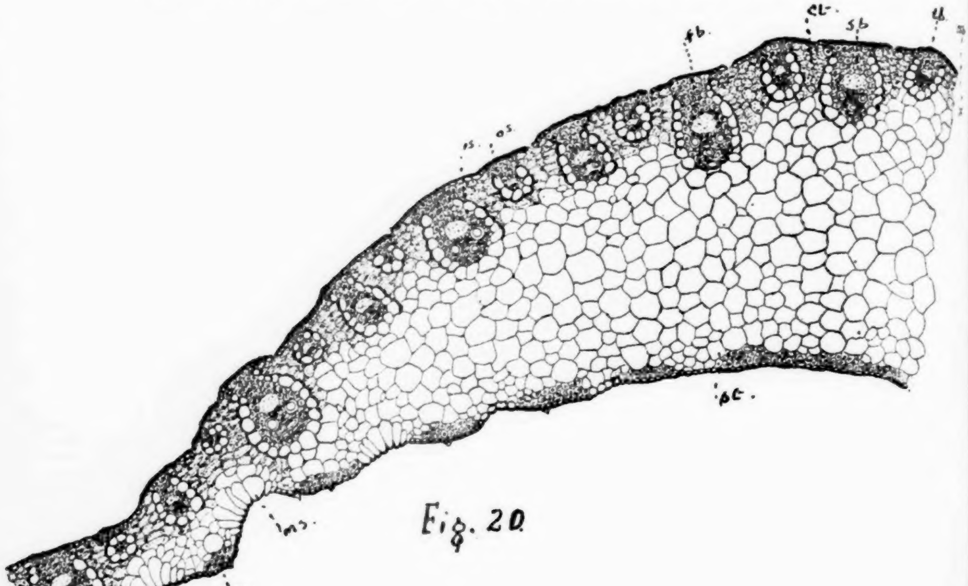


Fig. 20.

also in lateral regions), with the bundle-sheath interrupted by abaxial stereome strands; bundles of third order opposite motor cells. Chlorophyll tissue forming masses of radiating cells round bundles, often separated by strands of clear cells extending from motor cells to abaxial epidermis. Motor cells distinct, with central cell much deeper than broad. Abaxial epidermis opposite bundles consisting of rows of cells composed of groups of 2 short cells alternating with long cells; stomata in 2 or 3 rows in region between bundles.

Transvaal.—Zoutpansberg, Messina, *Pole Evans*; *Stent* (all in *Nat. Herb. Pret.*).

Cape Province.—Zwart Kop River, *Pearson* and *Galpin* 1580 and 1581 (*Herb. Mus. Austr. Afr.* and *Nat. Herb. Pret.*).

18. **S. fimbriatus** Nees in Fl. Afr. Austr., 156 (fig. 21).

Perennial; culms erect or geniculate, 2–3 feet long; blades flat or more usually involute, with inrolled margins, 12–25 cm. long, 2–4 mm. wide; panicle erect, more or less contracted, tapering to a narrow apex, 19–35 cm. long, 3–7 cm. broad, branches solitary, subspreading; spikelets greyish green to dark olive-green, up to 2 mm. long; lower glume about half the spikelet, the upper nearly equalling the spikelet.

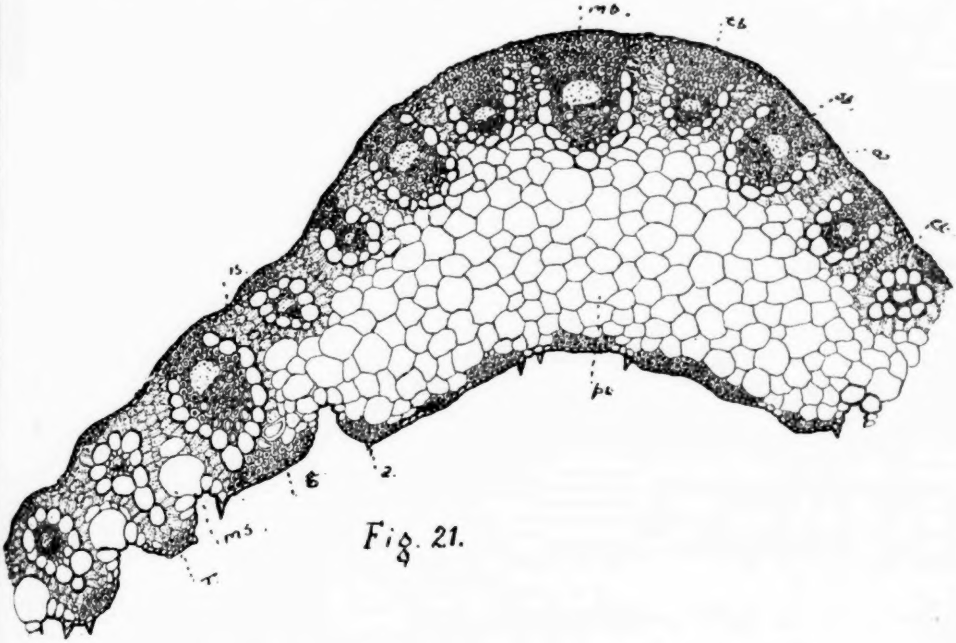


Fig. 21.

Leaf Anatomy.—Keel more or less distinct. Abaxial surface more or less undulating. Adaxial surface prominently ribbed except in keel region; ribs opposite first-order bundles broad and flat-topped, more or less rounded opposite other bundles outside keel region, with few asperities. Mechanical tissue above and below bundles. Parenchyma present in keel region. Bundles of first order outside keel region girdered; bundle-sheath in bundles of keel region, and other first-order bundles interrupted by abaxial stereome strands. Chlorophyll tissue forming masses of radiating cells round bundles. Motor cells distinct between ribs outside keel region with the central cell as broad as deep. Abaxial epidermis opposite bundles consisting of rows

of short cells alternating with rows of long cells; stomata in 1–3 rows in region between bundles.

Cape Province.—Albany, Carlisle Bridge, *Bowker* 1 (*Nat. Herb. Pret.*). Grahamstown, Brakkloof, *Hutton* 6 (*Alb. Mus. Herb.*); Peddie Road, *Dyer* 1367 (*Alb. Mus. Herb.*). Graaff-Reinet, *Bolus* 555 (*Alb. Mus. Herb.*). Humansdorp, below Zuurbron, *Fourcade* 2568 (*Nat. Herb. Pret.*). Caledon, Sir Lowry's Pass, *Schlechter* 1169 (*Alb. Mus. Herb.*). Uitenhage, *Prior* 26503 (*Herb. Mus. Austr. Afr.*). Beaufort West, *Pentz* 8332 (*Nat. Herb. Pret.*). Barkley West, *Kerrang* (*Nat. Herb. Pret.*). Queenstown, *Everett* 61 (*Nat. Herb. Pret.*). Lower Umfolosi, *Curson* 250 (*Nat. Herb. Pret.*). Vryburg, Warrenton, *Adams* 183 (*Alb. Mus. Herb.*); Armoedsvlakte, *Theiler* (*Nat. Herb. Pret.*, H. 20150, H. 20156, H. 20162, H. 20163, H. 20167, H. 20168, H. 20172, H. 20180, H. 20183, H. 20187, H. 20192, H. 20200, H. 20201, H. 20203, H. 20205, H. 20234); Vryburg, *Theiler* 148 (*Nat. Herb. Pret.*); *Henrici* 65 (*Nat. Herb. Pret.*). Kimberley, *Moron* 6 (*Nat. Herb. Pret.*); Riverton, *Wilman* (*Trans. Mus. Herb.*). Francis Town, *Gordon* 106 (*Nat. Herb. Pret.*). Prieska, *Bryant* 20045 (*Nat. Herb. Pret.*). Mafeking, *Pole Evans* 2416 (*Nat. Herb. Pret.*); *Goossens* 600 (*Nat. Herb. Pret.*).

Orange Free State.—Heilbron, Maccauvlei, *Brandmuller* 25 (*Nat. Herb. Pret.*). Senekal, *Goossens* 874, 756 (*P.U.C. Herb.*). Bloemfontein, *Rehmann* 3799 (*Alb. Mus. Herb.*); *Potts* 2461 (*Kew Herb.*). Boshof, Smitskraal, *Burtt-Davy* 10101, 11344 (*Nat. Herb. Pret.*); Beth-el-Pella, *Wolff* 18 (*Nat. Herb. Pret.*). Ladybrand, *Goossens* 591 (*Nat. Herb. Pret.*). Kroonstad, *Pont* 77, 136 (*Nat. Herb. Pret.*).

Basutoland.—Leribe, *Dieterlen* 84 (*Herb. Mus. Austr. Afr.*).

Transvaal.—Bloemhof, Fourteen Streams, *Burtt-Davy* 1580, 1584, 1691 (*Nat. Herb. Pret.*); Christiana, on farm Kaffraria, *Burtt-Davy* 12758, 12765, 13054, 13090, 14160 (*Nat. Herb. Pret.*); Schweizer-Reineke, *Burtt-Davy* 1684, 1691 (*Nat. Herb. Pret.*). Potchefstroom, near Machavi Station, *Burtt-Davy* 1476 (*Nat. Herb. Pret.*). Wolmaranstad, *Liebenberg* 2354, 2440 (*Nat. Herb. Pret.*); Boskuil, *Sutton* 117 (*Nat. Herb. Pret.*). Pretoria, Derdepoort, *Fouché* (*Nat. Herb. Pret.*); Rooikop, *Pole Evans* 157 (*Nat. Herb. Pret.*); Onderstepoort, *Vet. Res. Lab.* 6 and 15 (*Nat. Herb. Pret.*); Wonderboom, *Mogg* 16452 (*Nat. Herb. Pret.*). Vereniging, *Brandmuller* 25 (*Nat. Herb. Pret.*). Ermelo, Davel, *Burtt-Davy* 1656 (*Nat. Herb. Pret.*). Lydenburg, *Atherston* 1656 (*Alb. Mus. Herb.*); Roggersveld, *Rehmann* 3207 (*Alb. Mus. Herb.*). Potgietersrust, *Goossens* 596 (*Nat. Herb. Pret.*).

var. **latifolius** Stent in Bothalia, i, 4, 279.

A more robust plant with wider and longer panicles; leaves up to 12 mm. wide; culms up to 1·8 m. long.

TRANSVAAL.—Zoutpansberg, Klippan, *Rehmann* 5373 (co-type in *Alb. Mus. Herb.*). Waterberg, Mosdene, *Galpin* M. 460, M. 461 (*Nat. Herb. Pret.*). Potgietersrust, *Goossens* 596 (*Nat. Herb. Pret.*). Pretoria, Hamanskraal, *Burtt-Davy* 1086 (*Nat. Herb. Pret.*).

NATAL.—Without precise locality, *McKen* 44 (*Natal Herb.*). Clairmont, *Wood* 6055 (*Natal Herb.*). Camperdown, *Franks* (*Natal Herb., Alb. Mus. Herb.*, and *Nat. Herb. Pret.*). Durban, *Wood* 10490 (*Natal Herb.*); *Rehmann* 8626 (*Alb. Mus. Herb.*). Tugela River, *Buchanan* 245 (*Natal Herb.*).

SOUTH-WEST AFRICA.—Waterberg Plateau, *Boss* 35122 (*Trans. Mus. Herb.*); between Nauchos and Areb, (?) (*Mus. Herb. Austr. Afr.* 18518).

19. **S. virginicus** Kunth in Rev. Gram., i, 67, 1829 (fig. 22).

Perennial, stoloniferous; culms many-noded, sheathed to base of panicle, up to 38 cm. long; blades usually more or less flat, up to 10 cm. long, 2–6 mm. wide; panicle contracted and spike-like, 2–9 cm. broad; spikelets greyish green, 2–3 mm. long; lower glume half to four-fifths the spikelet, upper more or less as long as the spikelet.

Leaf Anatomy.—Keel absent and main bundle ill-defined. Abaxial surface smooth or faintly undulated. Adaxial surface prominently ribbed, with the ribs opposite first-order bundles broad and flat-topped; furrows between ribs narrow and deep; occasional asperities present. Mechanical tissue above and below bundles. Parenchyma absent. Bundles of first order girdered, with outer bundle-sheath interrupted by abaxial stereome strands. Chlorophyll tissue forming masses of radiating cells round bundles, usually separated by strands of clear cells extending from base of furrows to abaxial surface. Motor cells ill-defined at base of furrows. Abaxial epidermis opposite bundles consisting of rows of cells composed of groups of 2 short cells alternating with long cells; stomata often in 2 rows or absent in region between bundles.

CAPE PROVINCE.—Cape Peninsula, flats below Wynberg, *Bolus* 15062 (*Alb. Mus. Herb.* and *Nat. Herb. Pret.*); Cape Flats, *Rehmann* 1767 (*Alb. Mus. Herb.*); Green Point, *Pappé* 28138 (*Herb. Mus. Austr. Afr.*); *Ecklon* (*Herb. Mus. Austr. Afr.*). East London, *Hilner* 377 (*Alb. Mus. Herb.*); near Cove Rock, *Galpin* 7356 (*Nat. Herb. Pret.* and *Alb. Mus. Herb.*). Uitenhage, north of Vanstadens River, *MacOwen* 710 (*Herb. Mus. Austr. Afr.*); Redhouse, *Paterson* 498 (*Natal Herb.*); Uitenhage, *Ecklon* and *Zeyher* (*Herb. Mus. Austr. Afr.*); *Prior* 26501 (*Herb. Mus. Austr. Afr.*). Port Elizabeth, *Drège* 649 (*Alb. Mus. Herb.*); Zwart Kop River, *Ecklon* (*Alb. Mus. Herb.* and *Herb. Mus. Austr. Afr.*); Zout Vlei, *Britten* 1988 (*Alb. Mus. Herb.*). Bathurst, Pora river-mouth, *Hilner* 507 (*Alb. Mus. Herb.* and *Nat. Herb. Pret.*). Grahamstown, *Salisbury* (*Alb. Mus. Herb.*);

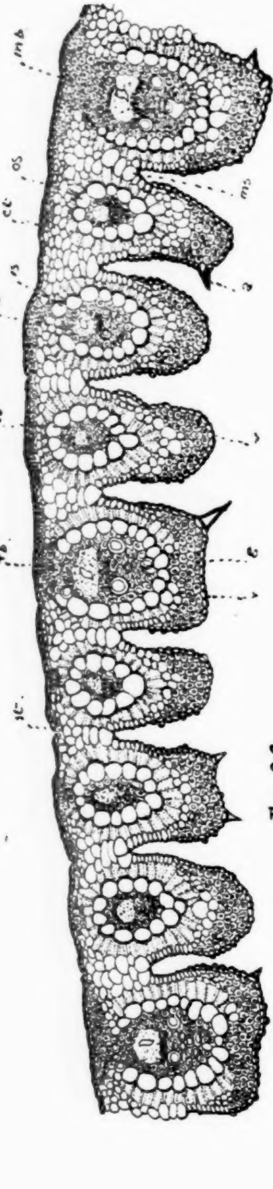


Fig. 22.

Tyson (*Nat. Herb. Pret.* and *Natal Herb.*); *Galpin* 2971 (*Alb. Mus. Herb.* and *Nat. Herb. Pret.*); *Potts* 186 (*Alb. Mus. Herb.*); *Britten* 796, 1930, 2688, 2863 (*Alb. Mus. Herb.*); *Flanagan* 997, 1892 (*Nat. Herb. Pret.* and *Trans. Mus. Herb.*). Port Alfred, *Burchell* 4032 (*Herb. Mus. Austr. Afr.*).

NATAL.—Verulam, *Wood* 10223 (*Natal Herb.*). Congela, *Wood* 11980 (*Natal Herb.* and *Herb. Mus. Austr. Afr.*). Durban, Bluff, *Wood* 12548 (*Natal Herb.*). Imargate, *Rump* 21034 (*Natal Herb.*).

TRANSVAAL.—Barberton, Komatipoort, *Rogers* 649 (*Alb. Mus. Herb.*).

20. **S. spicatus** Kunth in Rev. Gram., i, 67 (fig. 23).

Tufted perennial, stoloniferous: culms erect or ascending, up to 55 cm. high; blades linear, tapering to a fine point, flat or convolute, up to 20 cm.

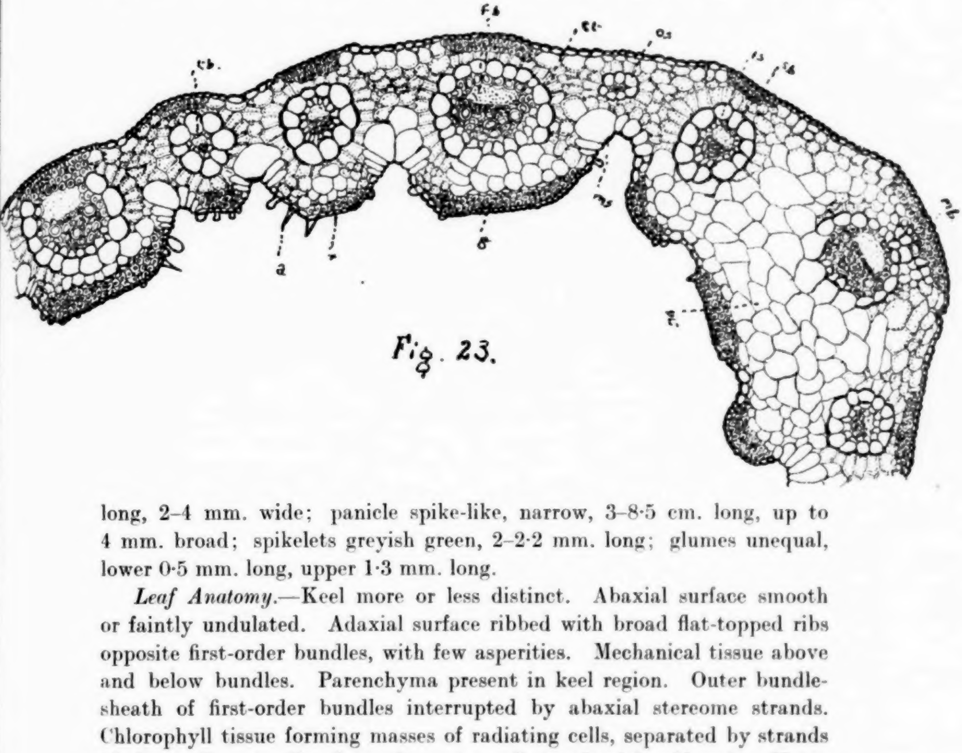


Fig. 23.

long, 2–4 mm. wide; panicle spike-like, narrow, 3–8·5 cm. long, up to 4 mm. broad; spikelets greyish green, 2–2·2 mm. long; glumes unequal, lower 0·5 mm. long, upper 1·3 mm. long.

Leaf Anatomy.—Keel more or less distinct. Abaxial surface smooth or faintly undulated. Adaxial surface ribbed with broad flat-topped ribs opposite first-order bundles, with few asperities. Mechanical tissue above and below bundles. Parenchyma present in keel region. Outer bundle-sheath of first-order bundles interrupted by abaxial stereome strands. Chlorophyll tissue forming masses of radiating cells, separated by strands of clear cells extending from the motor cells to abaxial epidermis. Motor cells distinct between ribs outside keel region. Abaxial epidermis opposite

bundles consisting of rows of cells composed of groups of 2 short cells alternating with long cells; stomata in 2 or 3 rows between ill-defined ribs.

BECHUANALAND.—Boesman Mine, *Pentz* 8574. Makarikari Pan, *Pole Evans* 2585; *Goossens* 616; *Pentz* 8418 (all in *Nat. Herb. Pret.*).

21. **S. bechuanicus** Goossens in Kew Bull., 197 (1934) (fig. 24).

Perennial: culms erect, slender, up to 1·1 m. long; blades flat or convolute, up to 20 cm. long, 3·5 mm. wide; panicle narrow, spike-like, up to 23·3 cm. long, 5–7 mm. broad, branches whorled; spikelets pale green, 2·5–2·75 mm. long; lower glume about 1 mm. long, upper about 2·5 mm. long.

Leaf Anatomy.—Keel more or less distinct. Abaxial surface faintly undulated. Adaxial surface prominently ribbed with flat-topped ribs opposite first-order bundles, and rounded opposite other bundles. Mechanical tissue above and below bundles. Parenchyma present in keel region. First-order bundles outside keel region girdered. Chlorophyll tissue forming masses of radiating cells round bundles, separated by strands of clear cells. Motor cells distinct between ribs outside keel region. Abaxial epidermis opposite bundles consisting of rows of cells composed of groups of 2 short cells alternating with long cells; stomata in 1 or 2 rows between bundles.

BECHUANALAND.—Boesman Mine, *Pentz* 8417 (type). Makarikari Pan, *Pole Evans* 3277, 3279 (all in *Nat. Herb. Pret.*).

22. **S. pyramidalis** Beauv. in Flora d'Oware et de Benin., ii, 36 (fig. 25).

Perennial: culms up to 1·5 m. long; blades flat or folded, 10–30 cm. long, 3–8 mm. wide; panicle narrow but lax, 18–44 cm. long, 2–10 cm. broad, tapering to the apex, branches usually solitary, spreading; spikelets dark greyish green, crowded, 1·7–2 mm. long; lower glume up to 0·5 mm. long, upper up to 0·9 mm. long.

Leaf Anatomy.—Keel well developed. Abaxial surface more or less smooth. Adaxial surface ribbed. Parenchyma prominent in keel region, with distinct lysigenous cavities. Lateral first-order bundles girdered. Motor cells in groups of 3–7, with central cell as deep as broad. Chlorophyll tissue not in definite masses of radiating cells round bundles. Abaxial epidermis consisting of rows of cells composed of groups of 2 short cells alternating with long cells opposite bundles; stomata in 1 or 2 rows between the ribs. Adaxial surface with asperities (*S. indicus* var. *laxus* (Nees) Stapf in Dyer, Fl. Cap., vii, 586; Stent in Bothalia, ii, 1*b*, 271).

TRANSVAAL.—Carolina, Bossies, *Burtt-Davy* 2955 (*Nat. Herb. Pret.*).

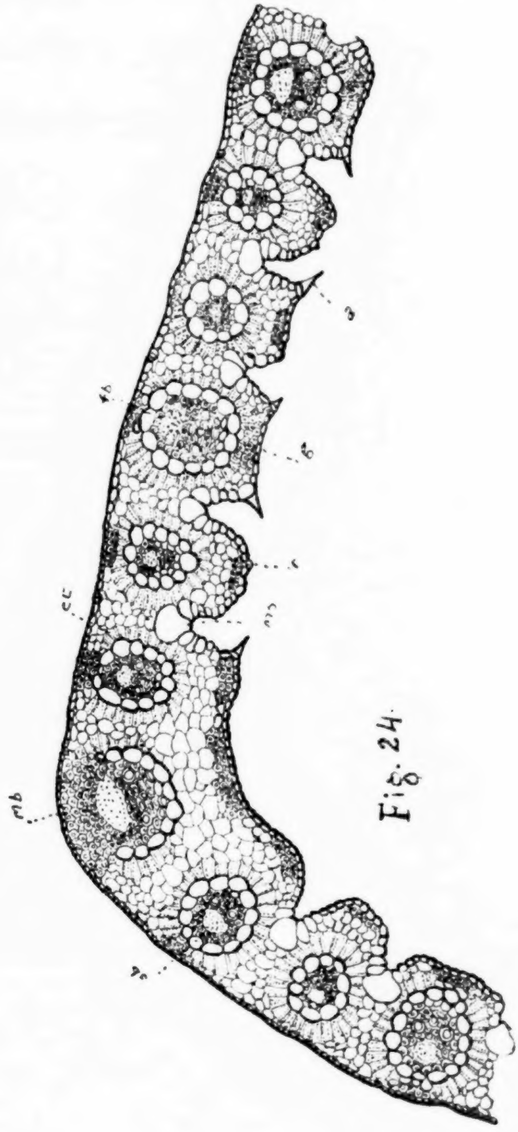


Fig. 24.

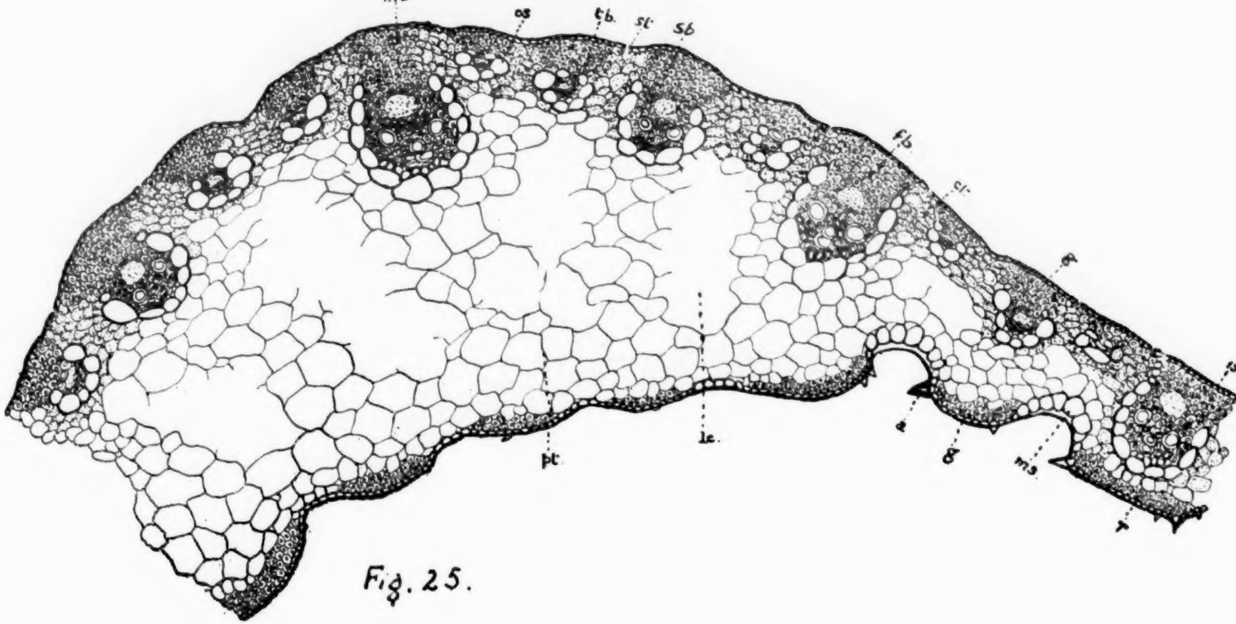


Fig. 25.

Lydenburg, Sterkkop, *Burtt-Davy* 414 and 478 (*Nat. Herb. Pret.*); Wolvenkraal, *Pole Evans* (*Nat. Herb. Pret.*). Barberton, *Liebenberg* 2504 (*Nat. Herb. Pret.*); Warmbad, *Stent* (*Nat. Herb. Pret.*). Zoutpansberg, Spelonken, *Junod* 115 (*Herb. Trans. Mus.*); Zoutpansberg, *Obermeyer* 527 (*Herb. Trans. Mus.*); Tzaneen, Letaba, (?) 4 and 6 (*Nat. Herb. Pret.*); Bushveld, *Rehmann* 5119 (*Alb. Mus. Herb.*); Woodbush, *Rehmann* 5704 (*Alb. Mus. Herb.*). Waterberg, Mosdene, *Galpin* M. 458, H. 21631 (*Nat. Herb. Pret.*); Warmbad, *Leendertz* 6664 (*Herb. Trans. Mus.*); Springbok Flats, *Burtt-Davy* 1137 (*Nat. Herb. Pret.*). Pretoria, Meintjeskop, *Stent*; Sunnyside, *Mogg* 16005; Henley-on-Klip, *Stent* (all in *Nat. Herb. Pret.*); Pretoria, *Leendertz* 12790 (*Herb. Trans. Mus.*); *Skea* 7987 (*Nat. Herb. Pret.*); *Verdoorn* 692 (*Nat. Herb. Pret.*); Irené, *McClean* 23 (*Nat. Herb. Pret.*). Johannesburg, *Bryant* B. 23 (*Nat. Herb. Pret.*).

Swaziland.—Stegi, *Burtt-Davy* 10597 (*Nat. Herb. Pret.*); Bremmersdorp, *Burtt-Davy* 3013 (*Nat. Herb. Pret.*).

Natal.—Hilton Road, *Schlechter* 6769 (*Herb. Alb. Mus.*). Durban, Berea, *Wood* 5924 (*Natal Herb.*). Isolo, Umtwynka, *Galpin* 6922 (*Nat. Herb. Pret.* and *Alb. Mus. Herb.*). Varkkop, *Rehmann* 7675 (*Herb. Alb. Mus.*). Pietermaritzburg, *McClean* 197 (*Nat. Herb. Pret.*). *Angus* 799 (*Nat. Herb. Pret.*). Ixopo, *Otto* 19997 (*Nat. Herb. Pret.*). Eshowe, *Kotze* 387 (*Nat. Herb. Pret.*). Zululand, *Jenkinson* 6 (*Nat. Herb. Pret.*). Without precise locality, *Buchanan* 243 and 18213 (*Natal Herb.*); *McKen* 45 (*Natal Herb.*).

Cape Province.—Tembuland, *Baur* 405 (*Herb. Mus. Austr. Afr.*). Bathurst, Kowie, *Hutton* 50 (*Alb. Mus. Herb.*); Blauwkrantz River, *Schlechter* 6867 (*Herb. Alb. Mus.*); Komgha, *Flanagan* 910 (*Nat. Herb. Pret.*); Kasuga River, *MacOwen* 1015 (*Herb. Mus. Austr. Afr.*). Grahamstown, *Daley* and *Sole* 171 (*Herb. Alb. Mus.*); Lovedale, *MacDonald* 10 (*Herb. Alb. Mus.*); Kentani, *Pegler* 1055 (*Nat. Herb. Pret.*). Middelburg, *Hewitt* 12100 (*Herb. Trans. Mus.*). Without precise locality, *Kolbe* 2632 (*Herb. Trans. Mus.*).

23. **S. capensis** (Willd.) Kunth in Enum. Pl., i, 212 (fig. 25). [=*S. indicus* (Linn.) R. Br.; Stapf in Dyer, Fl. Cap., vii, 586, and Stent in Bothalia, ii, 1*b*, 271.]

Perennial; culms erect or geniculate, 60–180 cm. long; blades flat or convolute, up to 20 cm. long, 2–4 mm. wide; panicle narrowly spike-like; spikelets dark greyish green, about 2·5 mm. long; glumes unequal, lower 0·8–1 mm. long, upper 1–1·6 mm. long.

Leaf Anatomy.—Anatomically similar to *S. pyramidalis* Beauv., but differs from it in that the panicle is densely contracted and spike-like.

Cape Province.—Humansdorp, Hofmansbosch, *Britten* 1217 (*Herb.*

Alb. Mus.): Flats, Witte Els Bosch, ***Fourcade*** 996 (***Herb. Alb. Mus.***). George, Montagu Pass, ***Burtt-Davy*** 12595 (***Nat. Herb. Pret.***). East London, on the slopes near Kefani River-mouth, ***Galpin*** 5823 (***Nat. Herb. Pret.***); East London, Dyer 2054 (*Alb. Mus. Herb.*); Kowie, ***Hutton*** 15*a* (***Herb. Alb. Mus.***); Port Alfred, ***Burtt-Davy*** 7888 (***Nat. Herb. Pret.***); ***Tyson*** (***Nat. Herb. Pret.***, H. 12558). Komgha, ***Flanagan*** 1257 (***Herb. Alb. Mus.***). Caledon, Sir Lowry's Pass, ***Schlechter*** 1166 (***Herb. Alb. Mus.***). Uitenhage, Zuurberg, ***Holland*** 99 (***Herb. Alb. Mus.***); near Sanatorium, ***Schonland*** 3194 (***Herb. Alb. Mus.***); Aloes, ***Drège*** (***Nat. Herb. Pret.*** 3079). Albany, Howicsonspoort, ***Schonland*** 368 and 4376 (***Alb. Mus. Herb.***). Grahamstown, ***Schonland*** 4402 (***Alb. Mus. Herb.***). King Williamstown, ***Leighton*** 24 (***Alb. Mus. Herb.***); ***Welsh*** 43 (***Nat. Herb. Pret.***). Maclear, ***Britten*** 4554 (***Alb. Mus. Herb.***); Zonder Einde, ***Barnard*** 27251 (***Herb. Mus. Austr. Afr.***). Riversdale, Valsch River, (?) 3612 (***Nat. Herb. Pret.***). George, ***Baker*** 20148 (***Nat. Herb. Pret.***). Cape Peninsula, in grass-veld near Cape Town, ***Ecklon*** and ***Zeyher*** 48 (***Herb. Mus. Austr. Afr.***); near Cape Town, ***Prior*** 26502 (***Herb. Mus. Austr. Afr.***); Kenilworth, ***Bolus*** 15049 (***Nat. Herb. Pret.***); slopes of Lion's Head, ***Zeyher*** 4497 (***Herb. Mus. Austr. Afr.***).

TRANSVAAL.—Pretoria, Wonderboom, ***Dickson*** 63 (***Nat. Herb. Pret.***); Pretoria, ***Chippendall*** 2 (***Nat. Herb. Pret.***). Potchefstroom, Dassiesrand, ***Le Roux*** S. 33 and S. 58 (***P.U.C. Herb.***).

ORANGE FREE STATE.—Brandfort, ***Burtt-Davy*** 14073 (***Nat. Herb. Pret.***).

Miss Stent in Bothalia, ii, 1*b*, 271, follows Stapf's classification of this species (Fl. Cap., vii, 586). She admits that she has only seen South African material and that she has no special knowledge of the type specimen. According to Mr. C. E. Hubbard of the Kew Herbarium in a letter to me, the name *S. indicus* (Linn.) R. Br. is used by many of the older authors to cover a group of closely related species (including *S. elongatus* R. Br., *S. Poirettii* Hitchc., *S. capensis* Kunth), or, as in the case of Stapf, *loc. cit.*, it has been wrongly applied to another species.

S. indicus (L.) R. Br., Prod. Fl. Nov. Holl., 170 (1810), is based on *Agrotis indica* L., Sp. Pl., 63 (1753), a species with a wide area of distribution in tropical America and also occurring in tropical Africa, and one which has been introduced into other parts of the world. It is characterised by rather narrow basal leaf sheaths, moderately lax panicle with slender ascending branches, small spikelets (1·5–1·8 mm. long), and slightly unequal glumes. R. Brown incorrectly identified with this species specimens which he had collected at Port Jackson in New South Wales; these are now referred to *Sporobolus capensis* (Willd.) Kunth.

S. capensis Kunth, Enum. Pl., i, 212 (1833), is based on *Agrostis capensis* Willd., Sp. Pl., i, 372 (1798).

Its synonymy is as follows: *Agrostis spicata* Thunb., Prodr. Fl. Cap.,

19 (1794), non Vahl (1790); *Panicum caudatum* Thunb., *loc. cit.*, non Lam. (1791); *Agrostis capensis* Willd., *loc. cit.*; *A. africana* Poir., Encycl. Meth. Bot. Suppl., i, 254 (1810); *Vilfa capensis* Beauv., Agrost., 181 (1812); *Sporobolus indicus* var. *capensis* Engl., Hochgebirgs, Trop. Afr., 127 (1892).

This species is probably native in South Africa, and also occurs on the mountains in East Africa and on the Cameroons Mountain. It was introduced into New Zealand and the coastal districts of New South Wales, where it is now extensively naturalised. *S. capensis* (Willd.) Kunth differs from *S. indicus* (L.) R. Br. in possessing broad basal leaf sheaths, a dense spike-like panicle, larger spikelets (2·0–2·5 mm. long), and very unequal glumes. It is closely related to *S. Poirettii* (R. and S.) Hitchc. (*S. Berteroanus* Hitchc. and Chase), a species which is common in tropical America and which possesses slightly smaller spikelets (1·7–1·9 mm. long).

The distinguishing features of the var. *laxus* (Nees) Stapf are indistinct and also very unreliable, for in the same panicle the upper glume may be longer or shorter than half the length of the spikelet. Furthermore, a critical examination both anatomically and morphologically of the specimens cited by Miss Stent, *loc. cit.*, under *S. indicus* var. *laxus* (Nees) Stapf and *S. pyramidalis* Beauv. has proved that there are a large number of transitional forms linking up the extreme cases of the variety and the latter species. I have little hesitation in referring the material of the former to the latter.

It is interesting to note that the anatomy of a leaf specimen of *S. indicus* (L.) R. Br. from Jamaica, which has kindly been placed at my disposal by the Kew Herbarium, agrees remarkably well with that of the South African material of *S. capensis* (Willd.) Kunth. From this it can be concluded that they are very closely related.

24. **S. transvaalensis** Goossens, sp. nov.; affinis *S. capensi* (Willd.) Kunth, sed foliorum laminis basalibus brevioribus, ramis paniculis distantius spiculatis, spiculis fere lucidis differt (fig. 26).

Gramen perenne, caespitosum. *Culmi* simplices, graciles, erecti, teretes, glabri, levesque, 1–3-nodi, usque ad 25 cm. alti; internodia plerumque exerta; nodi glabri. *Folia* plerumque basalia; vaginae basales usque ad 1·5 cm. longae, dense imbricatae, subteretes, glabrae, ad basin leves, ad apicem striatae, superiores usque ad 6 cm. longae, striatae, glabrae; ligulae brevissimae ciliolatae; laminae lineares, subobtusae vel in apicem longe attenuatae, planae vel convulatae, 1·5–2 mm. latae et usque ad 20 cm. longae, marginibus minute pectinatis. *Panicula*

erecta, spicata, usque ad 5 mm. lata et usque ad 5·5 cm. longa; axis glaber; rami solitarii, fere distanter spiculati, appressi, filiformis, usque ad 2·5 cm. longi; ramuli et pedicelli brevissimi. *Spiculae* uniflorae, fere lucidae; plus minusve 2·5 mm. longae. *Glumae* inaequales, submenbrenaceae, glabrae et leves; gluma inferior 0·75–1 mm. longa, oblonga, enervis; gluma superior 1–1·6 mm. longa, ovato-acuminata, 1-nervis. *Lemma* ovatum, subacutum, 2·5 longum, 1-nervis. *Palea* lemmati textura

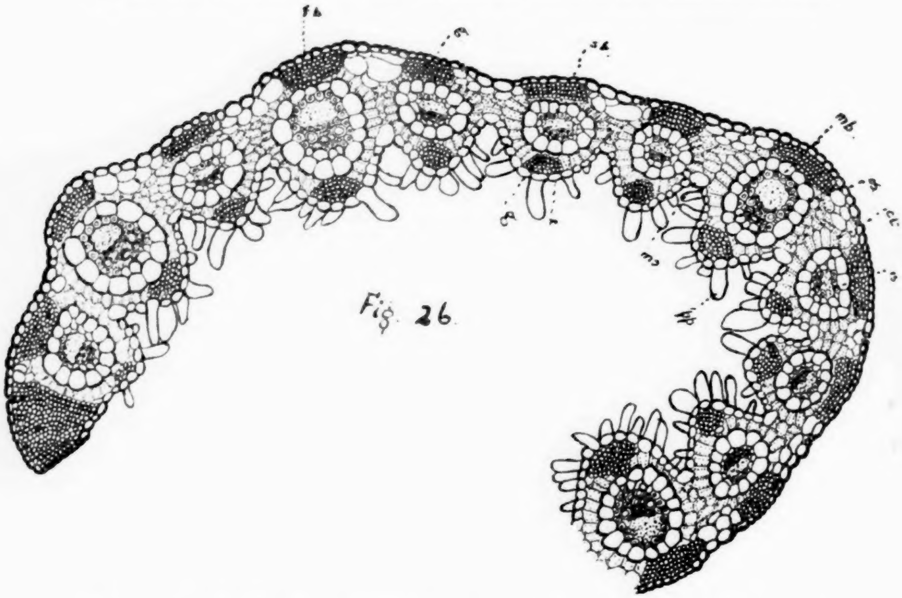


Fig. 26

et forma aequalis, truncata vel late obtusa. *Antherae* 3, 1 mm. longae. *Coaryopsis* quadrangularis, oblonga.

Transvaal.—Warmbad, *Leendertz* 1568 (*Trans. Mus. Herb.*).

Anatomical Description of Leaves.—Keel absent. Abaxial surface slightly undulated. Adaxial surface prominently ribbed with low rounded ribs bearing papillæ. Mechanical tissue above and below bundles and in margins. Bundles girdered; bundle-sheath continuous. Parenchyma absent. Chlorophyll tissue forming masses of radiating cells round bundles. Motor cells indistinct. Abaxial epidermis opposite bundles consisting of rows of short cells alternating with rows of long cells; stomata in 1 or 2 rows between ribs.

As far as the external morphological characters are concerned, this species shows close affinity with *S. capensis* (Willd.) Kunth, but differs

from it in the shorter basal leaves, the more distantly spiculate branches of the panicle, the paler and more shining spikelets, and the absence of parenchyma with lysigenous cavities in the midrib region of the leaf blade. Anatomically it comes near to *S. albicans* Nees, which, however, comes from the vicinity of Table Mountain in the Cape.

25. **S. panicoides** Rich. in Flor. Abyss., ii, 399 (fig. 27).

Annual; culms slender, branched, 4–5-noded, up to 40 cm. long; blades flat or folded, up to 16 cm. long, 5 mm. wide; panicle open, oblong to ovate, 8–20 cm. long, 4–6 mm. broad; spikelets greenish yellow flushed

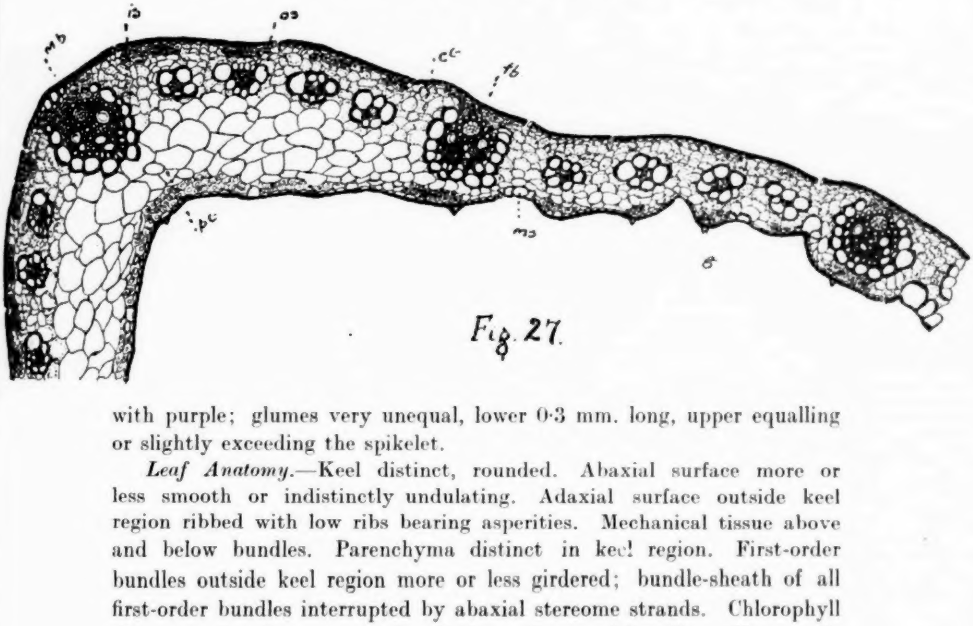


Fig. 27.

with purple; glumes very unequal, lower 0·3 mm. long, upper equalling or slightly exceeding the spikelet.

Leaf Anatomy.—Keel distinct, rounded. Abaxial surface more or less smooth or indistinctly undulating. Adaxial surface outside keel region ribbed with low ribs bearing asperities. Mechanical tissue above and below bundles. Parenchyma distinct in keel region. First-order bundles outside keel region more or less girdered; bundle-sheath of all first-order bundles interrupted by abaxial stereome strands. Chlorophyll tissue not forming masses of radiating cells round bundles. Motor cells not very distinct. Abaxial epidermis opposite bundles consisting of rows of short cells alternating with rows of long cells; stomata in 1 or 2 rows in region between bundles. Margins more or less without mechanical tissue.

Transvaal.—Pretoria, Rooikop, *Smuts* 2874 (*Nat. Herb. Pret.*). Zoutpansberg, *Smuts* 2879 (*Nat. Herb. Pret.*).

South-West Africa.—Tsumeb, *Dinter* 2785. Otawi, *Dinter* 5696. Kachipu, *Barnard* 45*a* (all in *Herb. Mus. Austr. Afr.*).

26. **S. argutus** Kunth in Enum. Pl., i, 215 (fig. 28).

Small annual; culms up to 6 cm. long, 1-noded; blades ovate-lanceolate, flat or folded, up to 12 mm. long, 2·5 mm. wide; panicle ovate to lanceolate, 16–22 mm. long, 10–16 mm. broad; spikelets dark olive-green, 1 mm. long; glumes very unequal, lower 0·3 mm. long, upper the length of the spikelet.

Leaf Anatomy.—Keel distinct. Abaxial surface undulately ribbed. Adaxial surface indistinctly ribbed, or more or less smooth, with numerous asperities. Bundles of first order outside keel region indistinctly girdered. Mechanical tissue sparsely developed above and below bundles. Parenchyma present in keel region. Chlorophyll tissue forming masses of radiating cells round bundles. Motor cells distinct between ill-defined

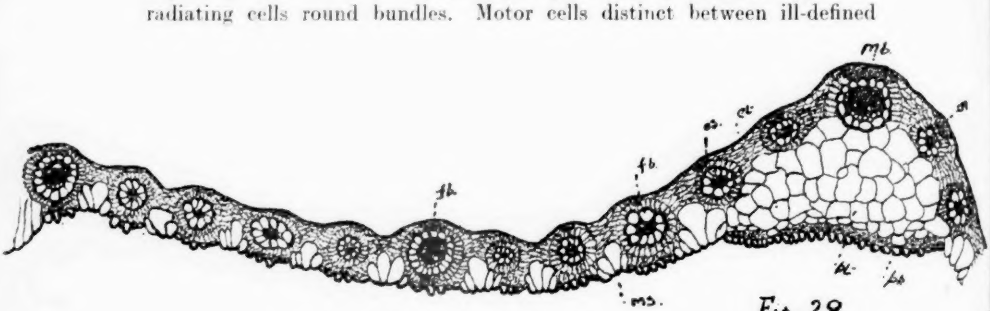


Fig. 28.

ribs, with central cell deeper than broad. Abaxial epidermis opposite bundles consisting of irregularly arranged cells, often consisting of groups of rows of cells composed of 2 short cells alternating with long cells; stomata in 1 or 2 rows between ribs (*S. parvulus* Stent in Bothalia, ii, 1*b*, 252).

Orange Free State.—Boshof, Smitskraal, *Burtt-Davy* 10127. Fauresmith, Groenvlei, *Smith* 3876. Bloemfontein, *Potts* 4612 (all in *Nat. Herb. Pret.*).

Cape Province.—Victoria West, *Smith* 2429 (*Nat. Herb. Pret.*).

27. **S. discoporus** Nees in Fl. Afr. Austr., 158 (figs. 29 and 29*a*).

Annual; culms 4–15 cm. long, 1–2-noded; blades very short, 4–15 mm. long, 4 mm. wide, margins ciliate; panicle ovate to lanceolate, lax, 2–5 cm. long, 1·5–3 cm. broad; spikelets secund, dark olive-green, 1·3 mm. long; glumes very unequal, lower about one-third of the spikelet, upper equalling the spikelet.

Leaf Anatomy.—Keel absent and main bundle not clearly defined from the rest. Abaxial surface more or less undulating. Adaxial surface

prominently ribbed with rounded ribs bearing papillae. Mechanical tissue above and below bundles. Parenchyma absent. Bundles with bundle-sheath continuous. Chlorophyll tissue forming masses of radiating cells

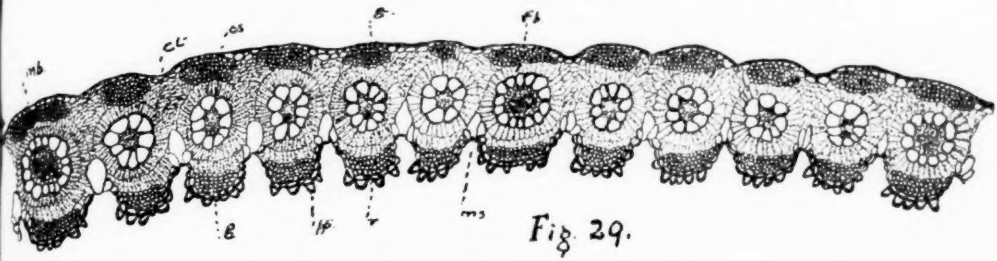


Fig. 29.

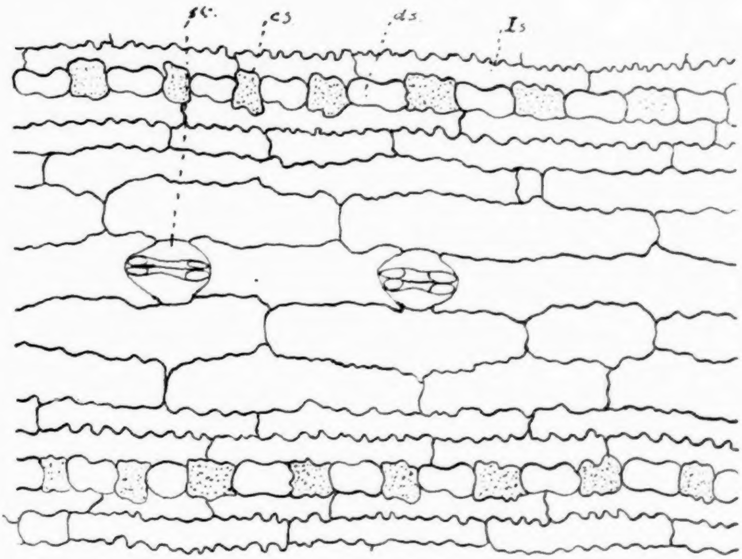


Fig 29a.

round bundles. Motor cells distinct, with central cell much deeper than broad. Abaxial epidermis opposite bundles consisting of rows of short cells alternating with rows of long cells; stomata in 1–3 rows between ill-defined ribs. Margins with prominently developed mechanical tissue, pectinate ciliate.

Cape Province.—Knysna, between Plettenbergs Bay and Vlakte

Station, *Burchell* 2750 (*Alb. Mus. Herb.*). Aliwal North, on stony plateau at Kraai River, *Drège* (*Herb. Mus. Austr. Afr.*). Vryburg, *Henrici* 138 (*Nat. Herb. Pret.*).

TRANSVAAL.—Ventersdorp, Goedgedacht, *Sutton* 644 (*Nat. Herb. Pret.*).

ORANGE FREE STATE.—Winburg, *Galpin* 7737 (*Nat. Herb. Pret.*). Bloemfontein, *Potts* 2398 (*Kew Herb.*). Thaba Nchu, *du Toit* 15923 (*Nat. Herb. Pret.*). Senekal, *Goossens* 1313A (*P.U.C. Herb.*). Kroonstad, Vals River, *Pont* 44, 118 (*Nat. Herb. Pret.*). Heilbron, *Goossens* 571 (*P.U.C. Herb.*).

BASUTOLAND.—Leribe, *Dieterlen* 660 (*Natal Herb.* and *Nat. Herb. Pret.*).

28. **S. nebulosus** Hack. in Eng. Jahrb., xi, 402 (fig. 30).

Small annual; culms erect, slender, 10–15 cm. high; blades setaceous,

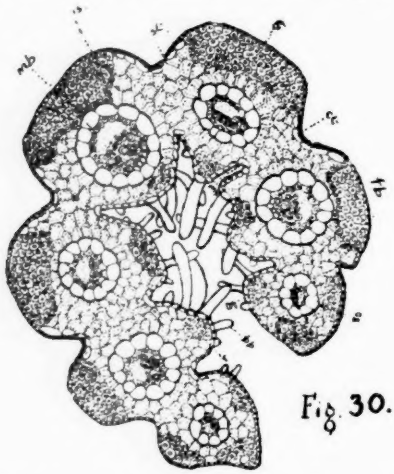


Fig. 30.

1·5–5 cm. long, 0·3 mm. wide; panicle ovate, lax; spikelets 1–1·2 mm. long, pale green; glumes subequal, both shorter than spikelet.

Leaf Anatomy.—Section of leaf rounded. Abaxial surface with 7 prominent flat-topped ribs and 6 furrows. Adaxial surface with 7 prominent rounded ribs bearing asperities. Parenchyma absent. Bundles 5–7, with a single second-order bundle between main bundle and lateral first-order bundle. Chlorophyll tissue forming masses of radiating cells round bundles. Motor cells indistinct. Abaxial epidermis opposite bundles consisting of rows of short cells alternating with rows of long cells; stomata in 1 or 2 rows between ribs.

SOUTH-WEST AFRICA.—Rossüng, between Swakopmund and Usakos,

Obermeyer 23810 (*Herb. Trans. Mus.*). Namib Desert, near Swakop River, *Bryant* K. 49 (*Nat. Herb. Pret.*).

This species, which is based on specimens which Marloth collected at Hykamchab (Haigamkhab?), South-West Africa, is not included in Stent's monograph. Mr. C. E. Hubbard points out to me that this species has also been recorded from the following localities: Haigamkhab, near Swakopmund, *Pearson* 502. Welwitsch, near Swakopmund, *Galpin* and *Pearson* 7418. Barmen, near Okahanja, *Dinter* 546.

29. **S. subtilis** Kunth in Rev. Gram., ii, t. 124 (fig. 31).

Perennial; culms erect, 4–5-noded, sheathed to base of panicle; blades very narrow, setaceously convolute, up to 15 cm. long, 1 mm. wide; panicle

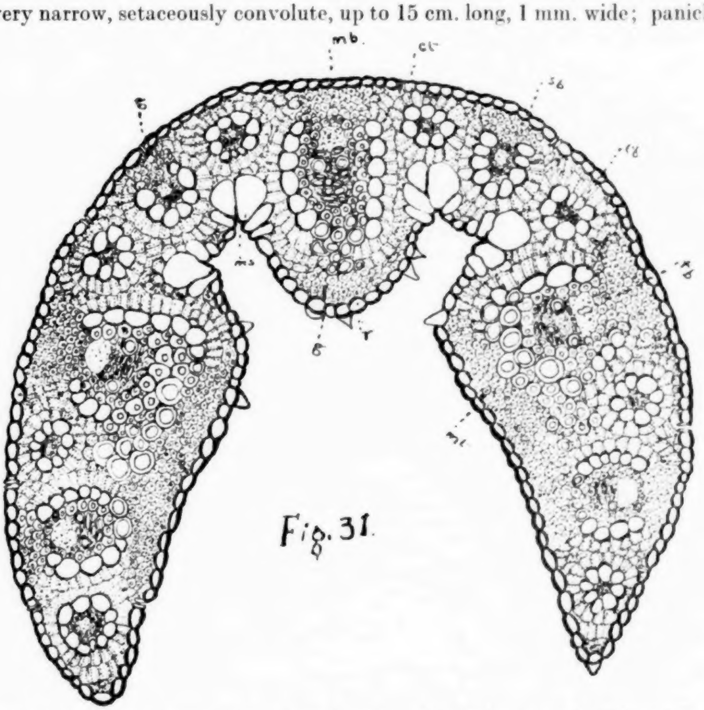


Fig. 31.

lax, up to 15 cm. long, 12 cm. broad, with white hairs in axils of branches; spikelets 1·5–1·75 mm. long; glumes subequal, lower about 1 mm. long, upper slightly longer.

Leaf Anatomy.—Section of leaf rounded. Keel absent. Abaxial surface smooth. Adaxial surface with a prominent rib opposite the main

bundle and with two large marginal structures. Parenchyma absent. First- and second-order bundles girdered; outer bundle-sheath of first- and second-order bundles interrupted by abaxial stereome strands. Chlorophyll tissue forming masses of radiating cells round bundles. Motor cells in four groups, with two groups on either side of central adaxial rib, with central cell large and more or less as deep as broad. Abaxial epidermis opposite bundles consisting of rows of cells composed of groups of 2 short cells alternating with long cells; stomata in 1 or 2 rows in region between bundles.

TRANSVAAL.—Belfast, *Doidge* and *Bottomly* (*Nat. Herb. Pret.*, H. 21753).

CAPE PROVINCE.—Florida, *Hutton* 614 (*Nat. Herb. Pret.* and *Alb. Mus. Herb.*).

SUMMARY.

1. In the introduction a brief account is given of the work done on the anatomy of grass leaves.

2. A general account of the anatomy of the basal leaves of *Sporobolus* R. Br. is given.

3. A key to the species, based on the anatomical features of the basal leaves and the external morphological characters, is put forward.

4. The anatomy of the leaves of the species are described, and the distribution of the species in South Africa given.

5. A new species is described, and several changes made in the existing classifications of this genus.

EXPLANATION OF FIGURES.

a = sharp hairs.
cs = cutinised cells.
ct = chlorophyll tissue.
ds = dumb-bell-shaped cell.
fb = first-order bundle.
g = stereome strand.
hs = hood-shaped structure.
is = inner bundle-sheath.
lc = lysigenous cavity.
ls = long cell.
mb = main bundle.
ms = motor cell.
mt = marginal structure.
os = outer bundle-sheath.
pp = papillae.
pt = parenchymatous tissue.
r = rib.
s = sinuation.
sb = second-order bundle.
si = silicified short cell.
st = stoma.
tb = third-order bundle.

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THE SOUTH AFRICAN FISHES OF THE FAMILIES SPARIDAE AND DENTICIDAE.

By J. L. B. Smith.

(With Plates XVIII–XXIX and twenty-five Text-figures.)

(Read June 16, 1937.)

It is only within the last two decades that the classification of the rich marine ichthyfauna of South Africa has been placed on any secure footing. For that we are indebted chiefly to the labours of Gilchrist and his co-workers, and later and more fully to the comprehensive and excellent work of Barnard.

Although this earlier work, especially that of Barnard, was of high standard, the field covered was so vast that critical and detailed study of each group was impossible. It is becoming increasingly obvious that a great part of the earlier work will have to be revised.

In the wake of those pioneers have come, within the last few years, several other workers who have directed their attention to South African fishes, and who have made very considerable changes, both taxonomic and nomenclatorial, in line with the more searching analysis characteristic of modern work.

The South African species of the family Sparidae have notably stood in need of critical revision. Although among them are many of considerable economic and taxonomic significance, yet the relationships between the species have never been properly investigated. Generic limits have been sadly lacking in uniformity; in some cases monotypic genera have been defined within limits which are very narrow by contrast with others, which have embraced forms so widely divergent and polymorphous as to be almost without parallel in any other families. Also there has been wide divergence of opinion about genera and generic limits among those who have worked upon our Sparid fishes. That particular work has in most cases been only a part of a larger treatise on the ichthyfauna of a whole region, so that the treatment of any individual group has been necessarily somewhat uncritical. A considerable amount of work has been done also elsewhere on the Sparidae, but a comprehensive revision, based on a world collection, is very badly needed. A work of that nature cannot

be carried out from South Africa, since only a few of our species appear to fall into cosmopolitan genera, while many important genera are not represented in our area.

The aim of the present investigation has been to place the taxonomy of the South African species on as sound a basis as possible. Fortunately a relatively large number of South African Sparid fishes appear to be endemic, and a number of those fall into purely endemic genera, whereby the problem of their relationships is considerably simplified. At the same time it is realised that the validity of the present arrangement can be established only by some worker who has at his disposal an adequate world collection, and who has access to orthotypes and early literature not available here.

What may be accepted as the first really practical definition of the family Sparidae was given by Regan (Ann. Mag. Nat. Hist., 1913 (8), vol. xii, p. 124). He there indicated the feature common to all fishes of that family as then recognised, *i.e.* the external overlapping of the maxilla by the extremity of the premaxilla (a character also of the related Maenidae, which differ chiefly in the very feeble dentition). Actually in Spariform fishes the distal extremity of the premaxilla has in its upper surface some form of groove of varying size and shape. In that groove rests a part of the lower edge of the distal portion of the maxilla. When the jaws are protruded or retracted, the premaxillary groove slides along the lower maxillary edge. The arrangement must contribute materially to the strength of the jaws. (See text-figs. 1 and 2.)

Regan at that time (*loc. cit.*) recognised 10 genera of Sparid fishes in South Africa, viz. *Dentex* Cuvier, *Pagellus* Cuvier, *Cantharus* Cuvier, *Box* Valenciennes, *Crenidens* Valenciennes, *Sparus* Linnaeus, *Pagrus* Cuvier, *Diplodus* Rafinesque, *Chrysophrys* Quoy and Gaimard, and *Gymnocrotaphus* Günther, of which the latter only was endemic (and monotypic).

Regan distinguished *Dentex* from other genera in that parapophyses are present from only the third precaudal vertebra and the first rib is sessile, while the rest have parapophyses on all the precaudals and none of the ribs sessile.

Barnard (Ann. S.A. Mus., 1927, vol. xxi, p. 683) recognised 39 species and 12 genera of Sparid fishes in South Africa: those of Regan (above, with *Caranthus* Barnard proposed to replace *Cantharus* Cuv., preoccupied) with the exception of *Chrysophrys* Q. and G. (which Barnard regarded as a synonym of *Pagrus* Cuv.), but with the addition of *Charax* Risso, *Boopsoidea* Castlenau, and *Tripterodon* Playfair. Barnard has since (see Smith, Trans. Roy. Soc. S. Afr., 1935, vol. xxii, p. 308) agreed that *Tripterodon* does not fall in the Sparidae, thus reducing the number of genera recognised to 11.

Fowler (U.S. Nat. Mus. Bull. 100, 1933, vol. xii, p. 64) recognised 34 species and 11 genera of Sparid fishes in South Africa: *Dentex* Cuv., *Gymnocranius* Klunzinger, *Argyrops* Swainson, *Sparus* Linn., *Boopsoidea* Cast., *Pagellus* Cuv., *Diplodus* Raf., *Puntazzo* Bleeker (= *Charax* Risso), *Sarpa* Cuvier (= *Box* Cuv. as defined by Barnard), *Spondyliosoma* Cantor (= *Caranthus* Barnard), and *Gymnocrotaphus* Gnthr.; together with numerous subgenera. Fowler's classification diverges widely from that of Barnard. He placed *Crenidens* Val. in the Girellidae, a diagnosis which is demonstrably invalid (*vide infra*). He recognised *Gymnocranius* Klunz. as distinct from *Dentex* Cuv., and *Argyrops* Swnsn. as separate from either *Sparus* Linn. or *Pagrus* Cuv., distinctions not accepted by Barnard at full generic rank. At the other extreme, Fowler grouped together in the single very wide genus *Sparus* Linn. (as by him defined) those species regarded by Barnard as falling in *Sparus* Linn. and in *Pagrus* Cuv. Actually Fowler did not accept any South African species as falling in *Pagrus* Cuv., an opinion which is probably correct. On the other hand, his wide limits for the genus *Sparus* Linn. are not in accord with most other work and are not accepted here.

Norman (Ann. S.A. Mus., 1935, vol. xxxii, pp. 5 ff.) has shown that the species accepted by Barnard as falling in *Caranthus* Brnrd. (and in *Spondyliosoma* Cantor by Fowler) actually represent 2 genera, viz. *Spondyliosoma* Cantor and *Pachymetopon* Günther, and a related species has been made the type of a new genus, *Polyamblyodon* Norman. *Pachymetopon* Gnthr. had been placed by Barnard in the Girellidae, and by Fowler in the Kyphosidae, but the relations of the maxillary bones have shown it to be a Sparid genus.

Of the above works that of Fowler is the most comprehensive, since it deals with almost the whole of the Sparid fishes of the Indo-Pacific and is of value in containing most of the references to Indo-Pacific species. Fowler's opinions, while diverging widely from those of Barnard (and of Norman), must receive consideration as emanating from a worker of great experience. At the same time his work on the Sparid fishes has obviously not been compiled with the care and accuracy that one might expect from so eminent a worker, and its value is much diminished thereby. In many instances inconsistencies render his keys to genera and species almost valueless. On general taxonomic grounds criticism may chiefly be directed against Fowler's grouping together in *Sparus* Linn. numerous widely divergent forms which cannot possibly be congeneric. That arrangement was probably due to lack of material and of information.

Norman also has done a considerable amount of work on South African fishes. Recently (*loc. cit.*) he has investigated the relationships of certain of our Scatharine fishes. His classification, though diverging widely from

what has hitherto been current, is accepted as it stands, though in parts the evidence on which it is based is rather slender.

These widely divergent and almost irreconcilable classifications have left our Sparidae in a state of chaos, which cannot be remedied save by a critical revision *de novo*. One of the chief aims of the present investigation has been to balance the genera so that the limits shall be of approximately equal extent. This has resulted in what may at first sight appear as an unnecessarily extensive division of established genera. Nevertheless it is believed that the arrangement proposed is sound, and consistent with the trend of modern analysis. The scheme is based not only upon the more important taxonomic characters, but also upon an extensive ecological study of our Sparid fishes.

The 41 South African species are here divided into 23 genera,* of which 7 are proposed as new, and 6 are revived after having been sunken as synonyms or as subgenera. Twelve are monotypic, and of those 6 appear to be endemic. Three genera have only 1 species in South Africa but are represented elsewhere.

To assist in the correlation of species from South Africa with those accepted as being in the same genus but found in other parts, the procedure has been instituted of naming from among the South African species one as the *regional genotype*.

In this work only those Sparid species which occur in the waters of the south and eastern coasts of South Africa have been included. The cold waters which wash the western shore of South Africa act as a barrier to prevent almost entirely the intermingling of the Atlantic with the Indo-Pacific forms which are characteristic of the south and eastern coasts of our region. The few species listed only from the northern region of the west coast are not typically South African, nor are they to be found in any collections in South Africa. Strictly, they belong more to the northern Atlantic or to the Mediterranean region, and their inclusion in the South African marine ichthyfauna list has been more of a convention than anything else.

It is remarkable how few systematists have paid attention to the nature of scales. Actually they merit detailed study and are often of great assistance in differentiation. Fowler generally gives a description of the nature of the scales for each species, but does not state from what part of the body the described scale has been taken. It is usual to find that while a scale from one special position on the body varies but little between

* South African marine fishes generally appear to fall into numerous genera, many monotypic or with only one or two representatives in our area. In the Gadidae 12 species fall into 10 genera, in the Brotulidae 11 species into 11 genera, while the 45 South African species of "Flat-fishes" fall into 30 well-defined genera.

specimens of any one species, yet the shape and form of the scales on most fishes vary widely on different parts of the body of any one specimen. Any figure or description of a scale is therefore of much diminished value in the absence of a statement indicating the exact position on the body from which it was taken.

In the Sparidae both cycloid and ctenoid scales are present, sometimes both on one species. Generally in that family the ventral scales are more strongly ctenoid than those on the dorsal surface; in some cases the dorsal scales are cycloid and those on the ventral surface ctenoid. Mostly the lateral line scales of Sparid fishes have a more or less strangulated (hour-glass-shaped) tubule, behind which, save in only a few species, are found pores, either a pair, or a double radiating series.

It is of interest to note that at least some of the genera, as outlined in this work, receive support for their validity from the nature of the scales of the species, *e.g.* the scales of the species in each of the closely related genera *Austrosparus* n.g., *Acanthopagrus* Peters, and *Diplodus* Raf. on comparison show definite group similarities. In *Austrosparus* the lateral line scales are cycloid, with heavy tubules and radiating series of pores behind. Those of *Acanthopagrus* are weakly ctenoid, the tubule is much more slender, and at most only two fine pores show behind. In *Diplodus* the lateral line scales are strongly ctenoid, and there are either several transverse pores, or the tubule bifurcates with very fine branches. (See Plates XVIII–XXIII.)

Enlarged photographs of the scales of most species will be found in Plates XVIII–XXIX. One scale from above the lateral line, one lateral line tubular scale, and one from below the lateral line, each from an exactly defined position, are figured for each species. Also the exact size of the scale and of the specimen from which it was taken are given in each case.

It is desirable that dimensional limits about which there may be any doubt should be defined precisely. The following indicates what have been used in the present case:—

Length of Body.—From snout tip to the base of the mid-caudal rays (often obscured by scaling).

Length of Head and of Snout.—Not measured in profile, but in a straight line in each case; hence the dimensions of the head may appear to vary between the text and the figures, in which latter the length of the head would have to be measured in profile.

Length of Fins.—Measured from the body to the tip of the fin held out from the body.

Lateral Line Scales.—Tubular scales from the origin of the lateral line at the shoulder to the base of the mid-caudal rays (see Length of Body). Tubular scales on the caudal rays are not included.

Lateral transverse series are counted obliquely back from just before the origin of the dorsal fin.

Species of which no accurate drawing exists have been figured.

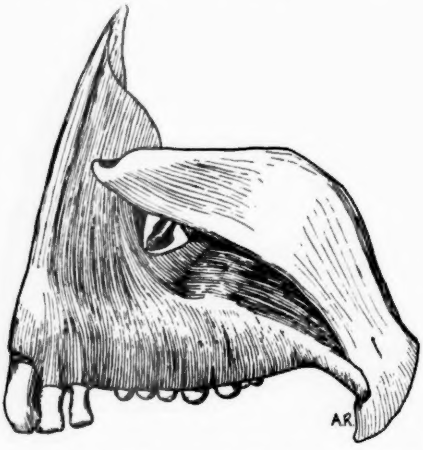

FIG. 1.—Maxilla and premaxilla of a typical Sparid fish. (*Austrosparus auriventris* Peters.)

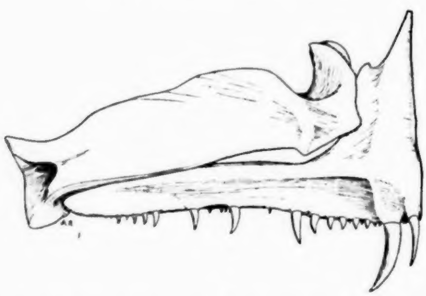

FIG. 2.—Maxilla and premaxilla of a typical Denticid fish. (*Polysteganus argyrozona* Valenciennes.)

Those figures have been prepared with chief regard to strict dimensional accuracy. In the case of any very large or very small specimen a suitably reduced or enlarged photograph has been employed from which to plot the outline, etc. In other cases a method has been used which ensures an accurate outline, points of insertion of fins, etc. This is briefly described below, since it may prove of assistance to others. Along the margins of a

rectangular board 15 by 12 inches stout pins are driven in exactly 1 cm. apart and numbered serially. On the board itself are drawn connecting lines opposite pins. The fish is then laid on this board and ordinary sewing cotton woven tightly across and along from the pins so as to form a network of 1 cm. squares (corresponding with the lines on the board) over the whole body. On a piece of Bristol board are drawn squares of size suitable to any reduction or enlargement required, and the outline, etc. plotted on this from the squares over the specimen. Naturally the method is most suitable for compressed fishes, but may be applied to practically all forms.

The Sparidae as formerly accepted by most workers are here divided into two families, the Sparidae and the Denticidae. This appears to be justified both by internal and external structure, as well as by general habits and habitat.

The following key indicates the main lines of division between the two families:—

1. All precaudal vertebrae with parapophyses; no ribs sessile. Premaxillary rami rather deep and heavy, especially proximally, and not much longer, if at all, than pedicels (see fig. 1). Dentition sectorial, or rapto-tritorial, or secto-tritorial. Teeth never all acute, conical teeth when present always accompanied by molariform teeth. Typically inhabit shallow water, surf, or estuaries, rarely exclusively predatory . . . . *Sparidae.*
2. Precaudal vertebrae with parapophyses from the third, and the first rib sessile. Premaxillary rami rather slender and shallow, longer than pedicels (see fig. 2). Dentition primarily raptorial. Teeth all acute, anterior always typically caniniform or fanglike, large blunt molariform teeth never present. Typically inhabit deeper water than the Sparidae, do not enter the surf or estuaries save by accident. Almost exclusively predatory . . . . . . *Denticidae.*

Family SPARIDAE.

Body compressed, or moderately compressed, elevated, oval or elongate-oval.

Mouth small or moderate, slightly to greatly protractile. Maxilla partly or entirely concealed beneath preorbital. Teeth various: conical and molariform together; or only incisiform; or incisiform and molariform teeth together may be present in each jaw; occasionally villiform teeth occur in a band behind the outer teeth. No palatal teeth in South African species. Outer teeth typically implanted in sockets; replacement by vertical succession.

Gills 4, a slit behind the 4th. Gill-rakers either tubercular, or lanceolate, relatively few. Gill-membranes free from isthmus. Pseudobranchiae

present. Air-bladder simple, or bifurcated, with or without caudal prolongations. Pyloric caeca few.

Dorsal single, seldom deeply notched. 3 anal spines, the 2nd sometimes enlarged. Ventrals of a spine and 5 rays with axillary scale. Caudal always forked or emarginate.

Scales cycloid, or weakly or strongly ctenoid, or variously mixed; usually scales on ventral surface more strongly ctenoid than dorsal scales. Soft dorsal and anal naked with basal sheath, or lightly or densely scaly basally.

Skull typically with well-developed occipital and parietal crests. Frontals sometimes produced forward acutely. Premaxillary pedicels rarely reaching frontals, seldom as long as rami. The upper margin of the distal extremity of the premaxilla with some form of groove, in which rests part of the lower surface of the maxilla; a part of the extremity of the premaxilla always overlaps the maxilla externally. Dentaries usually deep and heavy, occasionally cavernous and of light structure. (*Pterogymnus.*) A strong subocular shelf developed forward from the second suborbital. Vertebrae constantly 24 (10 + 14). All precaudals with parapophyses and no sessile ribs.

The South African species fall into three fairly well-defined groups, each of which is for convenience of key simplification here accorded subfamily rank.

The South African species of the family are mostly prolific, and many occur in such numbers as to be of great economic significance. They are mostly shore fishes, a few entering or frequenting tidal estuaries. The flesh of most species is highly esteemed.

Key to the Subfamilies of the Sparidae.

1. A group of enlarged antero-exterior teeth in each jaw, not continued laterally; if conical, not more than 8; if incisiform, not more than 9 in the front of the lower jaw . . . . *Sparinae.*
2. No separate group of enlarged anterior teeth. If outer series at all enlarged, then usually continued laterally, with more than 8 conical, or more than 9 incisiform in the outer series in the lower jaw.
   - A. Teeth of outer series slight and conical, with villiform teeth in a band anteriorly . . . . *Pagellinae.*
   - B. Teeth of outer series incisiform, even when acute or lanceolate . *Scatharinae.*

The classification of the Sparidae here proposed is outlined below. Genera and species marked * are endemic.

I. Sparinae.

Genus.	*Species.*
Acanthopagrus Peters.	*berda* Forskäl (type).
	bifasciatus Forskäl.
Austrosparus n.g.	*globiceps* C. and V.* (type).
	sarba Forskäl.
	auriventris Peters.
Sparodon n.g.*	*durbanensis* Cast.* (type).
Puntazzo Bleeker.	*puntazzo* Cetti (type).
Diplodus Raf.	*sargus* Linn. (regional genotype).
	trifasciatus Raf.
Argyrops Swnsn.	*spinifer* Forskäl (type).
	filamentosus Val.
Pterogymnus n.g.*	*laniarius* Cuv.* (type).
Cymatoceps n.g.*	*nasutus* Cast.* (type).
Chrysoblephus Swnsn.*	*gibbiceps* Cuv.* (type).
	lophus Fowler.*
	cristiceps Cuv.*
	anglicus G. and T.*
	puniceus G. and T.*
	laticeps Cuv.*
Porcostoma n.g.*	*dentata* G. and T.* (type).

II. Pagellinae.

Genus.	*Species.*
Pagellus Cuv.	*natalensis* Stndr. (regional genotype).
Lithognathus Swnsn.	*lithognathus* Cuv.* (type).
	mormyrus Linn.
Boopsoidea * Cast.	*inornata* Cast.* (type).

III. Scatharinae.

Genus.	*Species.*
Sarpa Bonap.	*salpa* Linn. (type).
Crenidens Val.	*crenidens* Forskäl (type).
Polyamblyodon * Norman.	*germanum* Barnard * (type).
Spondyliosoma Cantor.	*emarginata* Cuv. (regional genotype).
Pachymetopon * Gnthr.	*grande* Gnthr.* (type).
	blochii Val.*
	aeneum G. and T.*
	canescens Norman.*
	glaucum Norman.*
Gymnocrotaphus * Gnthr.	*curvidens* Gnthr.*

Subfamily Sparinae.

Molariform teeth always present. Anterior teeth few, conical or incisiform, always in a separate group, enlarged, not continued laterally. Dentition rapto-tritorial, or secto-tritorial, powerful. Mouth moderate. Premaxilla usually deep and heavy; rami not much, if at all, longer than pedicels. Maxilla typically heavy, sometimes with acute produced infero-anterior process. Scales cycloid or ctenoid, or both. Soft vertical fins naked or scaly. Interorbital naked and porous, or scaly. Preopercle flange naked, or partly or wholly scaly. Cheeks scaly. Dorsal never deeply notched between spinous and soft portions.

Other characters as outlined for the family.

Mostly shore fishes, some entering or even commonly found in estuaries and lagoons. No species graminivorous, usually otherwise more or less omnivorous, carnivorous when occasion offers, but the chief foods are mollusca and crustacea.

Only one species (*nasutus* Castlenau) grows to a large size, most others rarely exceed moderate size. Almost all are game fishes, but are strong and vigorous rather than speedy. The flesh of all species is of good texture and flavour, and this group is of considerable economic significance in South Africa.

The body colour is either silvery, olive, or some shade of red, and does not vary widely among the species in any one genus.

The nature of the interorbital region has proved of very great significance in the Sparinae. According as it is naked or scaly, so are the genera and species very sharply divided; a division rendered all the more significant since it is confirmed by numerous other features such as dentition, group colour, habits and habitat, etc. For example, the species of the group with naked interorbitals are silvery or olive in colour, frequently with dark cross-bars, and the preopercle flange is usually naked. Typically they inhabit shallow water, even surf, and commonly enter estuaries. Their anterior teeth are always incisiform, and the chief foods are mollusca and crustacea.

The species of the group with scaly interorbitals are red or reddish (one species only is black), and cross-bars are rarely present and then never dark or dusky. The preopercle flange is usually scaly. They are usually found in deeper water than those of the other group, and only in exceptional circumstances in the surf or in estuaries. The anterior teeth are always caniniform, and the species appear to be by choice carnivorous.

Key to South African Genera of the Sparinae.
(10 Genera; 20 Species.)

I. Scales on head not extending into the interorbital region.* Enlarged molars, if present, never of outer series. Anterior teeth usually incisiform. Ground colour silvery or olive, often dark cross-bars.
- A. Not more than 6 teeth in the anterior series in the upper jaw. Generally at least some scales above the lateral line cycloid.
  - X. Scales large, not more than 50 series. Soft dorsal and anal scaly at base. Lateral line scales ctenoid. Second anal spine enlarged. Dorsal spines strong . *Acanthopagrus.*
  - Y. Scales moderate to small, more than 55 series. Soft dorsal and anal naked, with low sheath. Lateral line scales cycloid. Second anal spine not or scarcely enlarged. Dorsal spines moderate or slender.
    - [*a*. Anterior teeth conical. Scales small, more than 70 series. All scales cycloid. Mediterranean and North-West Africa . . *Sparus.*]
    - *b*. Anterior teeth incisiform. Scales moderate, 55–65 series. Scales on lower half of body ctenoid. South Africa and Indo-Pacific.
      - i. Incisors subequal. Pectorals longer than head. Frontals moderately broad, interorbital not twice eye . *Austrosparus.*
      - ii. Two median incisors in each jaw very much larger than others. Pectorals shorter than head. Frontals broad, interorbital more than twice eye . *Sparodon.*
- B. More than 6 teeth in the anterior series in the upper jaw. All scales ctenoid.
  - X. Snout long and pointed. Hind teeth uniserial . . *Puntazzo.*
  - Y. Snout obtuse. Molars in 2–4 series . . . . *Diplodus.*

II. Scales on head extending well into the interorbital region. Enlarged molars, when present, always of outer series. Anterior teeth usually conical. Ground colour usually pink or red. Cross-bars rarely present, and then never dark or dusky.
- A. Preopercle flange naked. Scales fairly large, not more than 7 above the lateral line. At least one dorsal spine filamentous, longer than head . . . . *Argyrops.*
- B. Preopercle flange scaly. Scales moderate or small, more than 7 above the lateral line. None of the dorsal spines filamentous, sometimes elongate but not longer than head.
  - X. Scales moderate, less than 70 series. 12 or fewer

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* The interorbital is a region generally taken as the "front of the head between the eyes." For the purpose of the present work it is more accurately defined as follows: The upper limit of the interorbital region is taken as that line at right angles to the dorsal profile farthest from the snout, which is tangential to any part of the upper margin of the orbit. The lower limit is an orbit breadth below.

dorsal spines. Maxilla at least partly exposed. Posterior nostril oval or slit-like.
- *a.* Soft dorsal and anal naked, with low sheath. Outer anterior canines flaring outwards. Preorbital fairly shallow . . . . *Pterogymnus.*
- *b.* Soft dorsal and anal scaly basally. Anterior conical teeth subvertical. Preorbital deep.
  - *x.* Molars biserial in upper jaw. Scales above lateral line much smaller than those below. Preopercle flange only partly scaly. Soft dorsal and anal black, ground colour dusky . . *Cymatoceps.*
  - *y.* Molars in more than two series in upper jaw. Scales above lateral line not much smaller than those below. Preopercle flange completely scaly. Soft dorsal and anal, and ground colour pink or red . . . *Chrysoblephus.*

Y. Scales small, more than 70 series. 13 dorsal spines. Maxilla completely concealed. Posterior nostril circular, small . . . . *Porcostoma.*

All previous workers have accepted South African species as falling in the typical genus *Sparus* Linn., of which the Mediterranean species *aurata* Linn. is the genotype. A detailed examination of graduated stadia of that species, and a comparison with equivalent stadia of our species supposedly congeneric, has shown that the South African species do not fall in *Sparus* Linn. That is to say, I cannot recognise them as congeneric with the species *aurata* Linn.; they are as clearly distinct generically from that species as from, *e.g.*, the species of *Diplodus* Raf. The typical genus *Sparus* has been included in the key to the Sparine genera in order to show the main relationships. Later it will be shown also in the Denticidae that the typically Indo-Pacific species are generically distinct from species confined to the Atlantic.

Genus *Acanthopagrus* Peters.

1855. Peters, Arch. Naturg., Pt. 1, p. 242. Type *vagus* Peters. No description. (Copied from Fowler, U.S. Nat. Mus. Bull. 100, 1933, vol. xii, p. 145. P. 158, *vagus*=*berda* Forsk.)

Body more or less ovate, moderately deep. Eye moderate. Posterior nostril elongate-oval. Mouth small, terminal; snout moderately sharp; profile concave or straight before eye. 4–6 acute or blunted subconical or incisiform teeth anteriorly in each jaw; no villiform teeth behind. Rounded molariform teeth in 3–5 series in each jaw; inner posterior slightly enlarged. Opercular spine exposed. 11 dorsal spines, strong;

fin originates over or in advance of the hind opercular margin; base of fin more than half body length. 2nd anal spine enlarged, stout. Pectoral longer than head. Soft dorsal and anal densely scaly at base. Scales large, cycloid to feebly ctenoid, not more than 50 series. Lateral line scales ctenoid, tubules slender. Cheeks scaly. Interorbital naked, porous. Muzzle and preopercle flange naked.

Olive or silvery, with or without cross-bars.

Genotype *berda* Forskäl.

Two species in South Africa, *berda* and *bifasciatus* Forsk., both of which extend into the Indo-Pacific. Probably the Indo-Pacific species, *australis* Gnthr., *latus* Houttuyn, and *cuvieri* Day, will also be found to fall in *Acanthopagrus*.

Acanthopagrus is a very distinct genus, at least as far as the South African Sparidae are concerned. From *Austrosparus* n.g., *Sparodon* n.g., and *Diplodus* Raf. it is distinguished by the larger scales, stronger fin spines, shape of snout, and markedly by the dense scaling on the soft dorsal and anal fins.

Acanthopagrus is clearly distinguished from the remaining Sparine genera by numerous features, *e.g.* naked interorbital, scaling, colour, etc., so that it is very surprising that Peters's genus has not before received recognition.

Key to the South African Species.

I. Dark cross-bars on head. Teeth oblique . . . . *bifasciatus*.
II. No bars on head. Teeth vertical . . . . *berda*.

Acanthopagrus berda Forskäl.

(Pl. XVIII, fig. 2, and text-fig. 3.)

1933. Fowler, *loc. cit.*, pp. 157–158 (References and Synonymy), and p. 146, *Sparus madagascariensis* Val. (?).

This species is so widely distributed and so well known that only the briefest description is necessary.

Body ovate, snout subconical. Depth 1·9–2·5, head 2·9–3·2 in length of body. Eye 3·5(juv.)–5, snout 2·6–3·3, interorbital 3·8–4·2 in length of head. Preorbital depth 1·1–2·0 in eye. Interorbital scarcely convex, porous, opercular spine prominent. Gill-rakers 9–11, slender. Maxilla extends below front third of eye, not concealed. 4–6 subconical teeth anteriorly in upper, 6–8 in lower jaw. 4 or 5 series of moderate molars in upper, 3–4 in lower jaw, inner posterior larger.

D XI, 11–12 : originates above or in advance of hind margin of operculum. Spines stout: 1st 5–6, 4th longest 2–2·2, last 3–3·5 in head, shorter

than soft rays, 4th ray 2–2·2 in head, edge of soft fin rounded. Base of dorsal 1·9 in body length.

A III, 8–9 : inserted below soft dorsal origin. 2nd spine curved and enlarged, 1·6–1·8 in head, 3rd $\frac{2}{3}$ of 2nd, first soft ray 1·9 in head, remainder shorter, edge of fin rounded. Pectoral longer than head, 2·5–2·7 in body; ventrals 3·5–3·7 in body, reach to vent. Caudal forked.

Scales moderate, those above lateral line cycloid, those below weakly

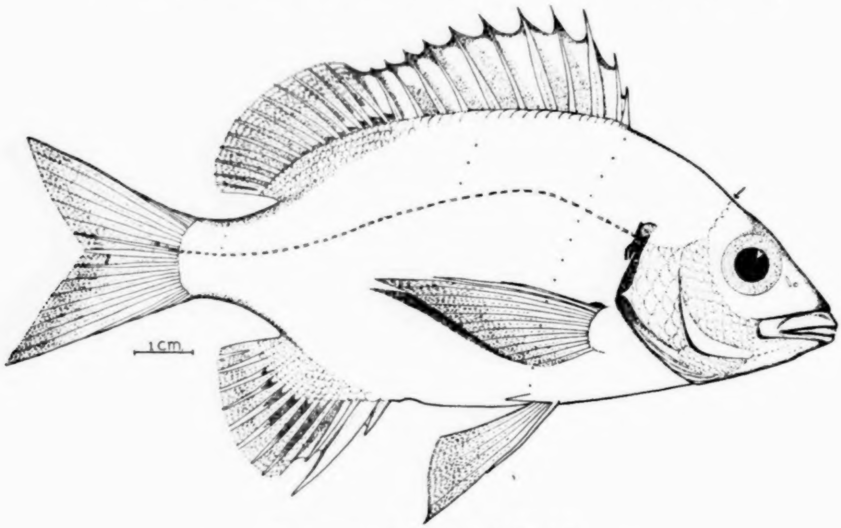

FIG. 3.—*Acanthopagrus berda* Forskäl.
The rows of dots show number and disposition of scales. The small arrow shows anterior limit of scaling on head.

ctenoid. Lateral line scales feebly ctenoid, tubule narrow (Pl. XVIII, fig. 2). l.l. 43–46, l.tr. $\frac{4\text{–}5}{9\text{–}11}$, 5–6 cheek scales. Scaling on head extends above hind pupil margin. Preopercle flange, muzzle, and interorbital naked. Soft dorsal and anal densely scaly basally.

Colour.—Silvery to olive, lighter below, sometimes lines along the scale rows, or scales with dusky edges. A dark blotch at lateral line origin, usually extending to membrane about opercular spine. Dorsal, caudal, and anal with some blackish markings; pectorals and ventrals light.

Locality.—Zwartkops estuary, Algoa Bay (rare), more plentiful eastwards to Natal and farther north, plentiful in estuaries, especially the young.

Distribution.—Apparently throughout the tropical Indo-Pacific.

Length.—Up to 400 mm. (S.A.): 750 mm. (India) (Day).

This widely distributed species appears to be somewhat polymorphous, with very numerous synonyms. It is not improbable that *berda* will eventually be divided into several subspecies or races.

Mr. Bell-Marley, to whom reference elsewhere is made, has expressed the opinion that two species are confused in *berda* in South Africa. I have not yet been able to satisfy myself, from available material, that they exist. Mr. Marley is, however, an acute observer and has had unique opportunities of handling a vast amount of material, so that the matter may be regarded as not yet settled.

Certainly the types of *robinsoni* G. and T. and of *aestuarius* G. and T. are clearly identical and referable to *berda* Forsk. Colour has little significance in species which live both in estuaries and in the sea. A fish which in surf or on sandy bottom in the sea is bright silvery, when taken in an estuary will generally be darker in colour; specimens from muddy areas high up the river may be even deep olive-dusky.

berda was placed in *Pagrus* Cuv. by Barnard (Ann. S.A. Mus., 1927, vol. xxi, p. 703) and in *Sparus* Linn. by Fowler (*loc. cit.*, 1933). *berda*, however, most emphatically does not belong to those genera, nor to any previously recognised in South Africa.

Acanthopagrus bifasciatus Forskäl.

(Pls. XVIII and XXIV and text-fig. 4.)

1933. Fowler, U.S. Nat. Mus. Bull. 100, vol. xii, p. 160 (copied) (References and Synonymy).

Body fairly deep, dorsal profile steep, prominent bulge at interorbital; snout pointed, concave before eyes. Depth 2, head 2·8 in body length. Eye 3·3, snout 2·6, interorbital 3·1, and postorbital 2·5 in length of head. Preorbital depth 2 in eye. Interorbital strongly convex, porous. Opercular spine prominent.

Mouth moderate, maxilla extends below centre of eye. In upper jaw 6 incisiform teeth with subconical bases, roots longitudinally produced. In the lower jaw 6 long incisiform teeth, both sets rather oblique. Molariform teeth in 4 series in upper, in 3 in lower jaw, posterior of middle series largest. Outer lateral series in upper jaw with more or less trenchant edge. Gill-rakers moderate, 11 on lower limb of anterior arch. Pyloric caeca moderate, 4–5.

D XI, 13 : originates in advance of hind margin of opercle. Spines stout, 3rd longest 2·2 in head, last 3·4 in head. Soft rays longer than last

spine. Mid rays longest, edge of fin rounded. Base of dorsal 1·7 in body length.

A III, 10 : inserted below middle of soft dorsal. 2nd spine strong, 1·9 in head, 1·3 times 3rd. Soft rays longest anteriorly, edge of fin gently convex. Pectorals 1·2 times head, reach well beyond anal origin. Ventrals 1·2 in head, reach beyond vent but not to anal. Caudal forked.

Scales large, some on nape and shoulder cycloid, the remainder ctenoid,

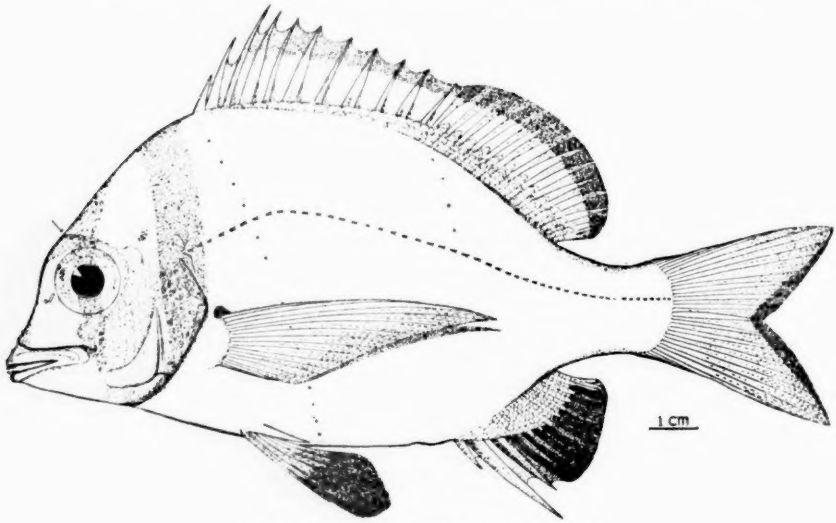

Fig. 4.—*Acanthopagrus bifasciatus* Forskäl.
The rows of dots show number and disposition of scales. The small arrow shows anterior margin of scaling on head.

more strongly towards ventral area. Radiating striae fairly numerous, all scales with gently rounded margins (Pl. XXIV, figs. 6 and 7). Lateral line scales feebly ctenoid, tubules narrow without posterior series of pores; hind margin of scales deeply notched (Pl. XVIII, fig. 6). l.l. 49, l.tr. $\frac{5}{12}$, 7–8 cheek scales, 28–30 predorsal, end above slightly behind front eye margin. Preopercle flange and muzzle naked. Interorbital naked, porous. Soft dorsal and anal densely scaly basally.

Colour.—Silvery olive, lighter below. A dark bar, little narrower than eye, from nape over opercle. A narrower and fainter bar from occiput through eye, ending at angle of mouth. Snout and interorbital dusky. Dorsal light dusky with broad dark marginal band. Anal dark except

last ray. Ventrals dark on distal $\frac{3}{4}$. Caudal light dusky with dark hind margin. Faint lines along the scale rows (probably only in preserved specimens).

Described from a specimen, 170 mm. in length, from Natal.

Distribution.—South Africa, Red Sea, India. Very rare in South Africa, and never south of Natal.

No South African specimens have apparently ever been described, certainly not in recent years. Fowler (Proc. Ac. Nat. Sci. Phil., 1934, vol. lxxxvi, p. 470) described a fish from Zululand as *bifasciatus* Forsk. which cannot be that species, but is more likely *Austrosparus sarba* Forsk. (*q.v.*). Fowler has probably not seen a specimen of *bifasciatus* from South Africa.

Barnard (Ann. S.A. Mus., 1927, vol. xxi, p. 703) gave a description of *bifasciatus* which was probably compiled. He placed that species in *Pagrus* Cuv., although his description stated the anterior teeth of *bifasciatus* to be incisors.

A. bifasciatus is a somewhat anomalous species and difficult to place. In some respects, *e.g.* oblique incisors, it is reminiscent of *Diplodus*, but numerous other features rule that out. It agrees best with *Acanthopagrus*, in which it is at present placed. It is not unlikely that *bifasciatus* will eventually be separated as a possibly monotypic genus.

Genus *Austrosparus* n.g.

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 684 (*Sparus*).

Body compressed, fairly deep. Head and nape moderately broad; snout blunt. Eye fairly large. Posterior nostril oval or slit-like. Mouth moderate. In upper jaw 4–6, in lower 4–8 subequal heavy incisiform teeth, edges entire, or tricuspid in juvenile stadia (*auriventris* Peters), never conical. No villiform teeth. Rounded molariform teeth in 3 or more series in each jaw, the inner posterior always enlarged, usually very much so. Maxillary and mandibulary bones very heavy. Opercular spine concealed. 11 dorsal spines, fairly slender. 2nd anal spine not enlarged. Soft dorsal and anal naked, with very low sheath. Dorsal base usually longer than half body length. Dorsal originates behind hind margin of operculum. Pectoral longer than head.

Scales moderate, more than 50 but less than 65 series. Lateral line scales and those above cycloid, only those on lower and hinder parts of body feebly ctenoid. Lateral line tubes broad, with posterior double diverging series of pores. Preopercle flange naked, or with a few scales (*auriventris*). Interorbital naked, porous.

Skull typical, frontals moderately broad. Colour silvery to silvery olive, with cross-bars in young, persist to adult in one species.

Genotype *globiceps* Cuvier. Other South African species *sarba* Forsk. and *auriventris* Peters.

The species *globiceps* and *sarba* have been placed in the genus *Sparus* Linn. by all recent workers. At the same time it has been obvious that most arrangements of our Sparid fishes have been based upon neither intensive research nor adequate material, and far too little attention has been paid to the nature of the dentition and of the scales. Further, the differences between groups of species accepted as generically distinct have been quite irrational. There are, for example, far more important differences of generic rank between the species *sarba* Forsk. and *berda* Forsk. than between *sarba* Forsk. and *sargus* Linn., and yet the majority of workers have held the former two congeneric, but retained *sargus* as distinct from *sarba* by generic rank.

The genotype of *Sparus* Linn. (i.e. *aurata* Linn.) differs from the South African species in certain important features, notably in the dentition, the anterior teeth being fang-like or caniniform from the earliest stadia, while those of our species are always incisiform, either with edges entire, or tricuspid in juveniles. Further, in *aurata* all the scales are cycloid and considerably smaller than in any of our species, while in *aurata* the preorbital is deeper and the eye smaller. With regard to dentition, it may be noted that diagnoses of *Sparus* Linn. generally state the front teeth are conical or caniniform. Fowler (*loc. cit.*, 1933, p. 64), in his key to Sparid genera, defined the group in which *Sparus* Linn. was included as having "front teeth conic, not compressed or incisor-like." This he confirmed some pages later in his diagnosis of the genus *Sparus* Linn. (*loc. cit.*, p. 145), where he stated "jaws with 4–6 conic canines anteriorly." Then in his key to the species of that genus (p. 147) he separated four species as the subgenus *Sparus*, in having "front teeth in each jaw incisors." Still further in those four species was included *australis* Gnthr., in the description of which Fowler stated (p. 152) "6 front conic canines in each jaw." In the same key Fowler defined *Chrysoblephus* Swainson as a subgenus distinct from *Sparus* in having the front teeth conic canines. Yet, on p. 161, *bifasciatus* Forsk., which he placed in *Chrysoblephus*, was stated to have "incisors 4–6 in each jaw."

Such inaccuracy and inconsistency is both regrettable and misleading. In any case the subgenus *Sparus* based upon the presence of incisiform teeth is invalid without special emendation, since the type of that genus has caniniform or fang-like anterior teeth.

In Spariform fishes the dentition is surely of considerable importance, and it is here treated as such.

In view of the evidence adduced, it would appear reasonable to accept *Sparus* Linn. as confined to the Mediterranean and Atlantic. Many of our species are related to *Sparus*, but completely separated geographically as they are, have diverged sufficiently to warrant generic distinction. Certainly they merit generic distinction from *Sparus* Linn. as much as do the species of *Diplodus* Raf.

Generally *sarba* Forsk., *globiceps* Cuv., and *durbanensis* Cast. have been grouped together. In the present work *durbanensis* is separated from the other two and forms the type of a new genus. With regard to *sarba* Forsk. it has been discovered that two distinct species had been confused under that name in South Africa. Mr. Bell Marley, Principal Fisheries Officer of Natal, has for many years held that view, but could find no worker to substantiate it. It has now been found that a species which is very abundant from the Cape all along the south coast of South Africa to Natal, hitherto stated to be *sarba* Forsk., is not that species, but has been identified with *auriventris* Peters, a hitherto doubtful name placed in the genus *Diplodus* Raf. There are therefore three species which fall in *Austrosparus*.

None of the species of *Austrosparus* grow to a large size. They feed chiefly upon mollusca, the dentition being extremely powerful; in large specimens the molars form an almost continuous pavement across the roof and the floor of the mouth.

The distribution of the species is interesting: *globiceps* is most abundant about the Cape, becoming scarcer eastwards; *auriventris* is most abundant along the coast from about Mossel Bay to Durban; while *sarba* does not extend farther south and west than about Port St. Johns, being unknown west of East London.

Key to the species of Austrosparus.

I. (*Austrosparus*) :
Preopercle flange naked. Incisors even in juveniles with entire edge.
A. Adult with dark cross-bars. Pectoral 1·1 times head . . *globiceps*.
B. No cross-bars in adult. Pectoral 1·3–1·4 times head . . . *sarba*.
II. (*Rhabdosargus* Fowler):
Preopercle flange with a few scales.
Anterior incisors tricuspid in juveniles . . . . . . *auriventris*.

Austrosparus globiceps Cuvier.

(Pls. XVIII and XXIII and text-fig. 5.)

1927. Barnard, Ann. S.A. Mus., 1927, vol. xxi, p. 685, fig. 23*a* (head).
1933. Fowler, U.S. Nat. Mus. Bull. 100, vol. xii, p. 148 (copied) (References).

Body more or less ovate. Dorsal profile of snout more or less undulate with marked interorbital prominence. Depth 2·4–2·6, length of head

2·9–3·2 in length of body. Eye 3·0–4·5, snout 2·4–3, interorbital 2·8–3·2 in length of head. Preorbital depth 1·0–1·7 (juv.) in eye. Opercular spine concealed. Gill-rakers short, 7–9 on lower part of anterior arch. Maxilla extends to below anterior part of eye. In upper jaw 4–6, in lower 4–8 incisiform teeth; in juveniles these teeth are acute, but become more chisel-edged with age. 4–5 series of molars in upper and 3–4 in lower jaw, fewer in young fishes, inner hinder molars much enlarged.

D XI, 11–12: inserted just behind hind margin of operculum. Spines slender, 3rd–5th longest, 1·8–2·2 in head.

A III, 10–11: inserted below anterior dorsal rays. Pectorals 1·1 times

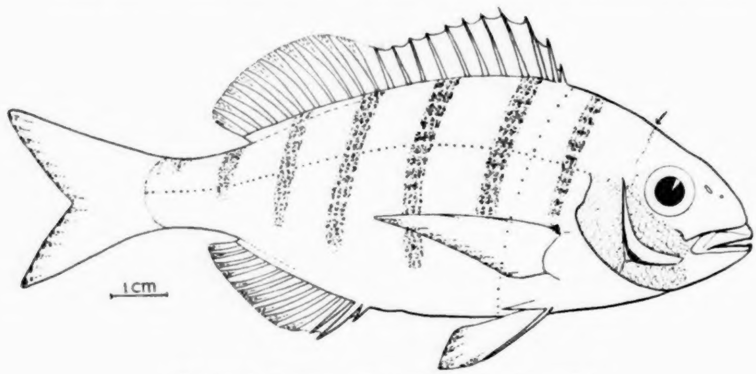

FIG. 5.—*Austrosparus globiceps* C. & V. (Juvenile.)
The rows of dots on body and head show number and disposition of scale rows. The small arrow shows anterior limit of scaling on head.

head, reach above anal spines. Ventrals 1·6 in head, reach vent. Caudal forked, upper lobe larger.

Scales moderate; lateral line scales and above cycloid. Radiating striae numerous. Scales on hinder and lower side feebly ctenoid (Pl. VI, figs. 6 and 7). Lateral line tubes broad with 2 very widely diverging series of 4–5 pores to hind margin (Pl. XVIII, fig. 5). l.l. 57–61, l.tr. $\frac{5\text{–}6}{14\text{–}16}$, 6 or 7 series across cheek. Predorsal scales end above hind third of eye. Preopercle flange and muzzle naked. Interorbital quite naked, porous.

Colour.—Silvery or dusky silvery above, lighter below. 6–7 narrow vertical dark cross-bars, more or less equally spaced, first over shoulder, last over peduncle. Axil of pectoral and opercular margin dark. Interorbital dusky. Dorsal and anal dusky, usually dark blotches between the rays. Other fins also dusky, mid-caudal rays sometimes dark at apices. Iris golden or bronzy.

Locality.—Coast of South-West Africa to the Cape and round to Natal.

Endemic in South Africa; attains a length of 500 mm. Occasionally occurs in very large shoals and often taken in nets. Economically important, the flesh being esteemed.

Small specimens are much like equivalent-sized *auriventris* Peters, which are similarly banded. The young of *globiceps* may always be distinguished by the naked preopercle flange and by the acute incisors, those of equivalent *auriventris* being tricuspid.

Austrosparus sarba Forskäl.

(Pls. XVIII and XXIII and text-fig. 6.)

1917. Gilchrist and Thompson, Ann. Durb. Mus., vol. i, pt. 4, p. 361 (*natalensis*).

1927. Barnard, *loc. cit.*, p. 687 (part).

1933. Fowler, *loc. cit.*, p. 149 (part).

1934. Fowler, Proc. Ac. Nat. Sci. Phil., vol. lxxxvi, p. 470 (*bifasciatus*).

Body ovate, dorsal profile steep, nape rather narrow. Depth 1·9–2·1, length of head 3·3–3·5 in length of body. Eye 3·3–4·3, snout 2–2·3, interorbital 3·3–4 in head. Preorbital depth 1·2–1·5 in eye, lower margin almost straight; interorbital not very prominent, porous. Gill-rakers 7–8, short. Maxilla extends to below pupil. In upper jaw 4–6, in lower usually 6, often with 2 median smaller, incisiform teeth; in young or half-grown fishes the incisors are rather pointed, become broader and flatter with age. In upper jaw 4–5 series of molariform teeth, 3–4 series in lower, the inner hinder enlarged, markedly so in large fishes, almost forming a pavement across the mouth.

D XI, 12–13: originates over or behind hind margin of operculum. Spines fairly stout, 4th usually longest, about 2 in head.

A III, 11: originates below anterior dorsal rays. Pectorals 1·3–1·4 times head, reach to above middle of anal, 2·3–2·4 in body length. Ventrals 1·2 in head, reach to or beyond vent. Caudal moderately forked.

Scales moderate, radiating striae numerous, margins broadly rounded, more so than equivalent scales of *globiceps*. Lateral line scales and those above cycloid. Scales on lower hinder parts ctenoid (Pl. XXIII, figs. 3 and 8). Lateral line tubes broad with 2 diverging series of pores behind (Pl. XVIII, fig. 3). l.l. 56–59, l.tr. $\frac{7\text{–}8}{12\text{–}14}$, 4–5 cheek scales. Predorsal scaling extends above centre of eye. Preopercle flange and muzzle naked. Interorbital entirely naked, porous.

Colour.—Dull silvery olive to silvery above, lighter below. An indistinct narrow stripe along each scale row, arched above lateral line, more or less straight below. Stripes clearer on preserved specimens. A faint axillary spot.

Locality.—Natal south coast, Durban, and north to Zululand, also in estuaries. Extends to the Indo-Pacific.

Grows to a length of 600 mm. or more.

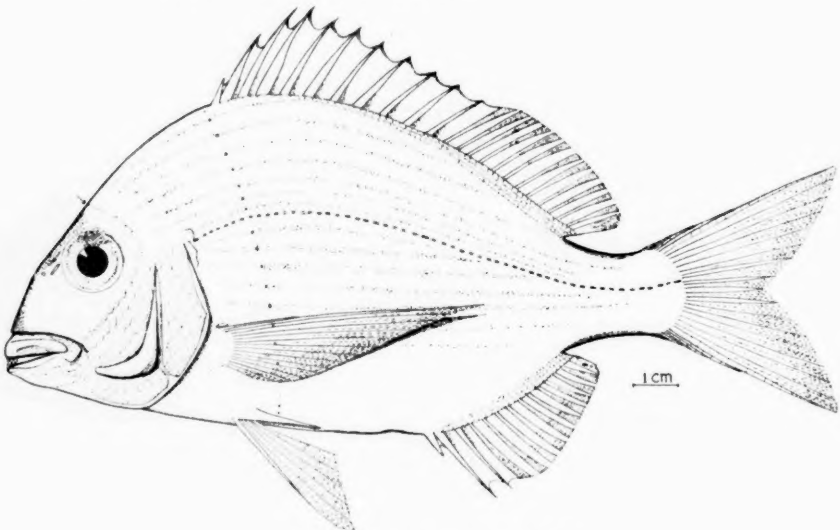

FIG. 6.—*Austrosparus sarba* Forskäl.
The rows of dots indicate number and disposition of scale rows. The small arrow shows anterior margin of scaling on head.

I have not seen a specimen of *sarba* Forsk. from the type locality (Red Sea), but there is little doubt that the Natal form is that species. *Sarba* does not appear to extend much south of Durban, certainly not west of East London. Specimens do not ever have the longitudinal golden band characteristic of the species *auriventris* Peters, which occurs also in Natal waters with *sarba*. The latter may easily be distinguished even in preserved specimens by the longer pectoral and naked preopercle flange; juveniles of the two species are readily distinguished by the nature of the incisors, those of *auriventris* being tricuspid.

Austrosparus auriventris Peters.

(Pls. XVIII and XXIII and text-figs. 1, 7, and 8.)

1835. Ruppell, Neue Wirbel, p. 110, pl. 28, fig. 1 (*sarba*).
1855. Peters, Arch. Naturg., p. 243 (*Diplodus auriventris*, locality Madagascar). (Copied from Fowler, *loc. cit.* below.)
1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 687 (*sarba* Forsk., part).
1933. Fowler, *loc. cit.*, p. 149 (*sarba* Forsk., part), p. 178 (*Diplodus auriventris* Peters).

Body elongate ovate. Dorsal profile sloping from nape, concave above

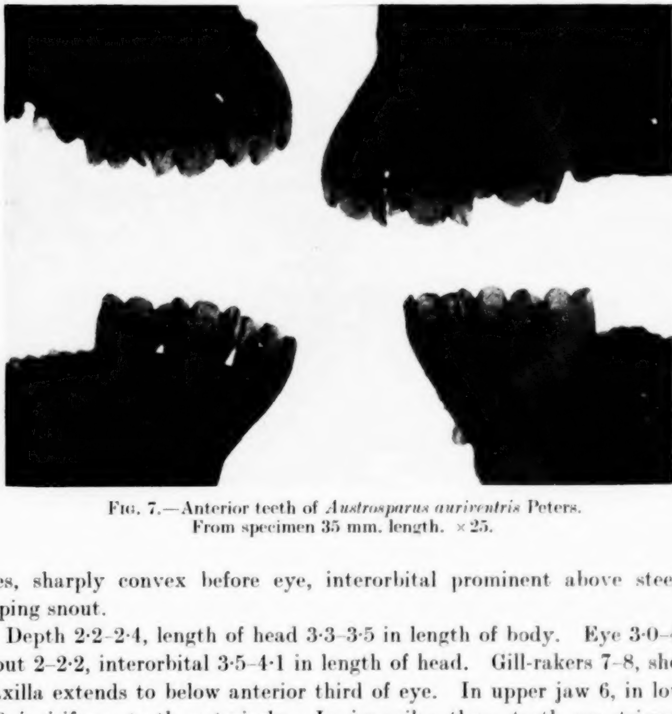

Fig. 7.—Anterior teeth of *Austrosparus auriventris* Peters. From specimen 35 mm. length. × 25.

eyes, sharply convex before eye, interorbital prominent above steeply sloping snout.

Depth 2·2–2·4, length of head 3·3–3·5 in length of body. Eye 3·0–4·0, snout 2–2·2, interorbital 3·5–4·1 in length of head. Gill-rakers 7–8, short. Maxilla extends to below anterior third of eye. In upper jaw 6, in lower 6–8 incisiform teeth anteriorly. In juveniles these teeth are tricuspid (text-fig. 7), the cusps diminishing with growth, but traces still visible in specimens 130 mm. in length. Up to the ordinary adult stadia the incisors form a continuous cutting edge, but in very large specimens they change to a blunted molariform shape. In upper 4–5, in lower jaw 3–4 series of molars, inner hinder enlarged, enlargement increasing with age.

D XI, 12–13: originates behind hind margin of operculum. Spines moderate, 4th longest 2·5–2·6 in head.

A III, 10–11: inserted below anterior dorsal rays. Pectorals 1·15–1·2 times head, do not reach beyond spinous anal, 2·7–2·8 in body length. Ventrals 1·4–1·5 in head, scarcely reach vent. Caudal moderately forked.

Scales moderate, those above lateral line vertically elongated. Radiating striae numerous. Lateral line scales and those above cycloid, scales on lower and hinder parts of body ctenoid (Pl. XXIII, figs. 1 and 2).

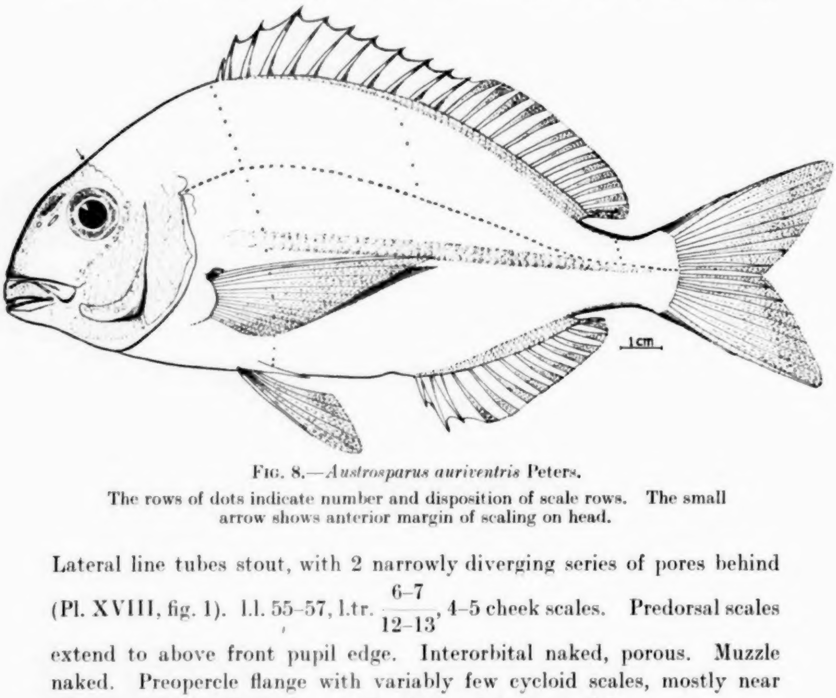

FIG. 8.—*Austrosparus auriventris* Peters.
The rows of dots indicate number and disposition of scale rows. The small arrow shows anterior margin of scaling on head.

Lateral line tubes stout, with 2 narrowly diverging series of pores behind (Pl. XVIII, fig. 1). l.l. 55–57, l.tr. $\frac{6\text{–}7}{12\text{–}13}$, 4–5 cheek scales. Predorsal scales extend to above front pupil edge. Interorbital naked, porous. Muzzle naked. Preopercle flange with variably few cycloid scales, mostly near ridge, present in all stadia, usually obscured in young fishes.

Colour.—Bright silvery; in estuaries usually varies to olive when water is dark, lighter below. When alive a straight narrow golden stripe along side, from near pectoral axil to caudal base just below lateral line; also some golden reflections from hind parts of scales in shoulder region. These golden markings fade rapidly on preservation. A dark axillary spot. Juveniles generally have 6–7 narrow dark cross-bars, which fade with age, though even adults show them as a nocturnal colour-phase. Dorsal olive to dusky. Nape dusky. When alive, anal and ventrals golden, especially

in juveniles. Iris golden. Preserved specimens develop faint streaks along the scale rows.

Locality.—From Breede River, Port Beaufort, along the coast eastwards, in all estuaries and in the sea, to Natal; Zululand; Madagascar.

Probably extends to Red Sea and Indian region. Largest recorded specimen 500 mm. total length (South Africa).

It is curious that this species has not previously been recognised in South Africa. When alive or fresh, even in the largest specimens, the golden lateral stripe is brilliant and obvious. With this is associated the scales on the preopercle flange, and the tricuspid teeth of juveniles, all distinctive features enabling the species to be distinguished from *sarba* and *globiceps* at all stadia and in all degrees of preservation.

There can be no question of the validity of *auriventris*. I have not seen Peters's original description, nor any (as *auriventris*) except that compiled by Fowler (*loc. cit.*, 1933, p. 178). But that description could hardly fit more exactly, and I have no hesitation in applying Peters's name to this species so very abundant in our South African estuaries.

When the three species of this genus are compared, it is found that *globiceps* is most abundant at the Cape, but becomes progressively scarcer eastwards. The young enter estuaries, but never in great numbers. *A. auriventris* is very abundant from Mossel Bay eastwards, especially in all tidal rivers, and occurs with *sarba* in Natal waters. *A. sarba* does not extend far south; in fact, among thousands of specimens of *Austrosparus* examined, taken between East London and Mossel Bay, I have never seen one typical *sarba*. The differences between *sarba* and *auriventris* can be neither sexual nor environmental, since both sexes of *auriventris* occur south of Natal, and both species occur together in Natal and farther north.

Although hitherto placed in *Diplodus* Raf., *auriventris* is unquestionably more closely related to *sarba* and *globiceps*.

It may be indicated that juveniles of *auriventris* often have dark cross-bars, so as to resemble equivalent stadia of *globiceps*; with growth these cross-bars disappear. However, *auriventris*, even when adult, will often show dark cross-bars as a nocturnal colour phase. Generally the dark markings fade after death, but in occasional specimens they persist. *Sargus holubi* Steindachner is probably merely *auriventris* with cross-bars (see Barnard, *loc. cit.*, 1927, p. 688).

Genus *Sparodon* n.g.

Body elongate oval. Head large and broad, interorbital wide. Snout blunt and heavy. Eye small. In each jaw 4 front incisors, the middle pair very much enlarged and curved, upper overlapping lower. Molar

teeth large, in 3 or more series, inner enlarged. Upper lip very thick at snout tip. 11 dorsal spines, slender. Dorsal base less than half body length. 2nd anal spine not enlarged. Soft dorsal naked with well-developed sheath, soft anal scaly basally. Pectoral shorter than head. Scales moderate, more than 50 but less than 65 series. Lateral line scales and those above cycloid, those on lower surface ctenoid. Lateral line tubes fairly broad, with 2 series of pores behind. Preopercle flange naked. Interorbital naked, porous.

Skull typical, frontals very broad.

Colour silvery, no cross-bars at any stage.

Genotype *durbanensis* Castlenau (monotypic).

S. durbanensis has hitherto been accepted as congeneric with *globiceps* and *sarba*, to which it is closely related, and as falling in the genus *Sparus* Linn. *S. durbanensis* shows features which appear to justify its separation from *globiceps* by full generic rank. The enlarged curved median incisors, the included lower jaw, very broad head, more elongate body, and other characters are distinctive. Also the habits, etc., of the species (*vide infra*) set it apart from the related forms mentioned above.

S. durbanensis is endemic, and so far as I can determine there are no species from other parts which might be congeneric. The genus *Sparodon* is thus endemic and monotypic.

Sparodon durbanensis Castlenau.

(Pls. XVIII and XXIII and text-fig. 9.)

1927. Barnard, *loc. cit.*, p. 687, pl. xxviii, fig. 4 (*Sparus d.*).

Head broad and heavy. Dorsal profile gently sloping from nape, concave above eyes, with slight interorbital prominence. Depth 2·6–2·9, length of head 3·2–3·4 in length of body. Eye 4(juv.)–6·5, interorbital 2·0–2·5, and snout 2·2–3 in length of head. Preorbital depth less than eye in juveniles (< 180 mm.), up to 1·5 times eye in large adults. Lower margin of preorbital undulate, curves down over much-exposed maxilla end. 8–9 short gill-rakers on lower limb of the anterior arch. Opercular spine visible. Mouth fairly large, maxilla extends to below middle of eye, lower jaw shorter than upper. In each jaw 4 narrow incisors, the median pair curved and much enlarged, those in upper jaw exsert, visible externally overlapping the lower jaw. Large molars in 4–5 series in upper and in 3–4 in lower jaw, inner hinder much enlarged. In large specimens the teeth form an almost continuous pavement across the jaw.

D XI, 11 : inserted well behind hind margin of opercle. Spines slender, 4th longest, 2·4–2·6 in head, remainder decrease to the last, soft rays

higher, 3rd as long as 4th spine. Edge of fin gently convex. Base of dorsal less than half body length.

A III, 10 : inserted below anterior dorsal rays, 3rd spine longer than 2nd. Pectorals 1·2–1·3 in head, do not reach above anal origin. Ventrals 1·6–1·7 in head, do not reach vent. Caudal moderately forked.

Scales moderate, hind margin irregularly undulate, radiating striae fairly numerous (Pl. XXIII, figs. 4 and 5). Lateral line scales and those above cycloid, ventral scales feebly ctenoid. Lateral line scales almost as long as wide, tubule broad with 2 diverging series of pores behind (Pl. XVIII, fig. 4).

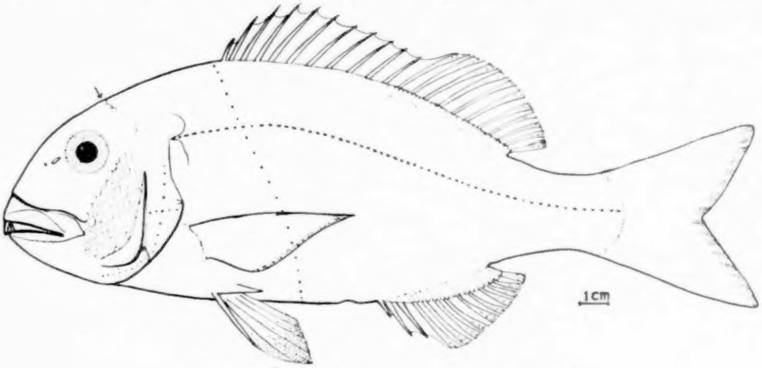

FIG. 9.—*Sparodon durbanensis* Cast. (Juvenile.)
The rows of dots indicate scale rows. The small arrow shows anterior limit of scaling on head.

l.l. 58–61, l.tr. $\frac{6\text{–}7}{14\text{–}15}$, 7 cheek scales. Predorsal scales extend forward above hinder third of orbit. Interorbital naked and porous. Muzzle and preopercle flange naked. Soft dorsal with well-defined scaly sheath. Soft anal scaly basally.

Colour.—Silvery, or silvery blue above, lighter below, dusky on preservation. Margins of dorsal, anterior part of anal, and distal half of ventrals dusky or dark. Very young specimens show longitudinal stripes (which fade with growth), while the ventrals, anal, sometimes also the caudal, are bright orange.

Locality.—From the Cape to Natal, not in estuaries, generally near rocks.

Sparodon durbanensis may be distinguished from all other South African Sparid fishes, in all but the youngest stadia, by the central pair of large curved incisors, those in the upper jaw being especially prominent, overlapping those in the lower, and visible even when the mouth is closed. In

very young fishes the anterior incisors are subequal, the abnormal development of the two median pairs commencing in fishes of about 70 mm. length. The dentition of *durbanensis* is heavier than in any other South African Sparid fish. In large adults the molars become very large, the inner posterior enlarged molars often being over an inch in length and half an inch in width.

Small specimens of this species are at times (October–January) fairly plentiful in rock-pools along the south-eastern coast. The body is deeper than in the adult, and fine longitudinal bands are usually present. The soft fins of the young are orange.

Durbanensis usually frequents rather shallow water and is frequently hooked at high tide in the inter-tidal zone. Large specimens are much prized by anglers, as they provide excellent sport and require skilful handling to land.

Genus *Puntazzo* Bleeker.

1933. Fowler, U.S. Nat. Mus. Bull. 100, vol. xii, p. 179.
1936. Fowler, Bull. Am. Mus. Nat. Hist., vol. lxx, pt. 2, p. 844.

Body fairly deep. Jaws and muzzle attentuate, almost beak-like; 8 truncate oblique incisors in a single series in each jaw, and behind those a single series of small compressed teeth.

This is typically a Mediterranean genus. A single species, *Puntazzo puntazzo* Cetti, has been recorded from South Africa, but only two specimens have been taken in over sixty years, so that it can scarcely be regarded as typically South African.

I have not been able to examine a specimen.

Genus *Diplodus* Rafinesque.

1933. Fowler, *loc. cit.*, p. 175.
1936. Fowler, *loc. cit.*, p. 836.

Body compressed, deep. Snout fairly blunt, steep. Eye moderate. Posterior nostril oval or slit-like. Mouth small, maxilla almost or completely concealed. Anterior teeth incisiform, oblique, truncated, 8–12 in each jaw; small molariform teeth in 2 or 3 series in each jaw. Dorsal spines fairly slender. Soft dorsal and anal naked with low sheath.

Scales moderate to small, ctenoid. Lateral line scales with pores posteriorly, in some cases as openings of bifurcating main tubes. Preopercle flange and interorbital naked. Colour silvery to yellow with or without dark cross-bars.

This genus has generally been accepted by systematists and is undoubtedly valid. It is more closely related to *Austrosparus* than to *Sparus*;

Austrosparus is in some respects intermediate between *Diplodus* and *Sparus*. It is exceedingly difficult to understand why systematists have accepted *Diplodus* but rejected equally well-defined genera such as *Chrysoblephus* Swainson, usually hitherto regarded as a synonym of *Sparus* Linn.

Two species of *Diplodus* occur in South Africa, *sargus* Linn. and *trifasciatus* Raf. It is probable that at some time they will be separated generically, for there are numerous differences of more than ordinary specific rank. Also the species of *Diplodus* from other parts would appear to be divisible into two groups on those same features. Nevertheless, it would not be wise to separate our two species generically without examining material from other parts, unfortunately not available here.

Key to the South African Species.

I. Lips thin, not continued across. Incisors large, 8 in upper jaw; molars triserial. No cross-bars in adult . . . . *sargus*.
II. Lips thick, continuous across symphysis. Incisors small, 12 in upper jaw; molars biserial. Cross-bars in all stadia . . . . . *trifasciatus*.

Diplodus sargus Linn.

(Pls. XIX and XXIV and text-fig. 10.)

1933. Fowler, U.S. Nat. Mus. Bull. 100, vol. xii, p. 175.

It appears to be accepted generally that the South African form is identical with the typical form of the Northern Atlantic and Mediterranean. At one time *sargus* from South Africa was separated as the variety *capensis* A. Smith. Barnard (1927, *loc. cit.*, p. 690) was not satisfied with that distinction, and Fowler (*loc. cit.* 1933, above) decided that the South African form was identical with the typical *sargus*, but regarded *noct* Val. as distinct. Subsequently Fowler (Bull. Am. Mus. Nat. Hist., 1936, vol. lxx, pt. 2, p. 840) has revived *capensis* as a species distinct from *sargus* Linn., stating that the latter has cross-bars in juvenile stadia, while *capensis* has not. If by *capensis* is meant the species occurring in South Africa, then the distinction is not valid, since the juveniles from South Africa show cross-bars, and even in half-grown specimens they are sometimes visible, especially as a nocturnal colour phase.

The species does not require more than a very brief description. Depth 1·9–2·3. Incisors large, 8 in each jaw; molars usually triserial above and below, 4 series above in larger fishes. Gill-rakers 10, moderate.

D XII, 14–15; A III, 13–14.

Scales ctenoid; lateral line tubes short and stout with several pores behind (Pl. II, fig. 1, and Pl. VII, figs. 1 and 2). l.l. 62–72, l.tr. $\frac{8\text{–}9}{18\text{–}19}$.

Juveniles are silvery with several narrow, dark cross-bars and a dark spot or saddle on peduncle. With age the colour darkens; large adults may be so dark that the peduncular blotch is scarcely discernible, while cross-bars are rarely observed beyond the half-grown stages save as a nocturnal colour phase. Length up to 400 mm. Known from all parts of the South African region.

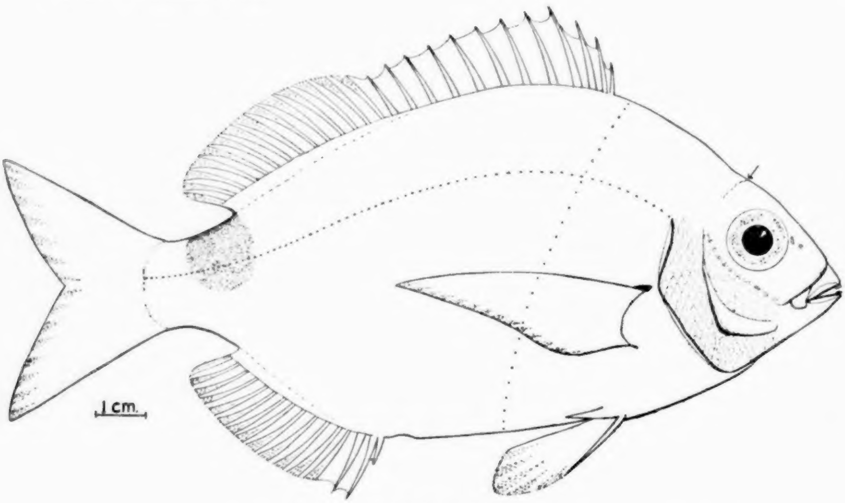

FIG. 10.—*Diplodus sargus* Linn.
The rows of dots represent number and disposition of scale rows. The small arrow shows anterior margin of scaling on head.

Diplodus trifasciatus Rafinesque.

(Pls. XIX and XXIV and text-fig. 11.)

1933. Fowler, *loc. cit.*, p. 177.
1936. Fowler, Bull. Am. Mus. Nat. Hist., vol. lxx, pt. 2, p. 837, fig. 362.

This well-known species scarcely requires redescription.

It is generally held to be identical with the form from the North Atlantic, and that view is accepted here, although the figures that I have seen do not resemble our fish very closely.

The chief differences between *trifasciatus* and *sargus* are: the former has thick lips continuous across the symphyses, the incisors are 12 in number and rather small, molars are in 2 series and small, the preorbital conceals the maxilla completely, while the lateral line tubes bifurcate and the branches open externally each by a large pore (Pl. II, fig. 2). Ordinary

scales are shown in Pl. XXIV, figs. 4 and 5. The colour, when alive, is usually yellowish, and the broad dark cross-bars are present in all stadia.

This species occurs throughout the South African region and attains a length of 500 mm.

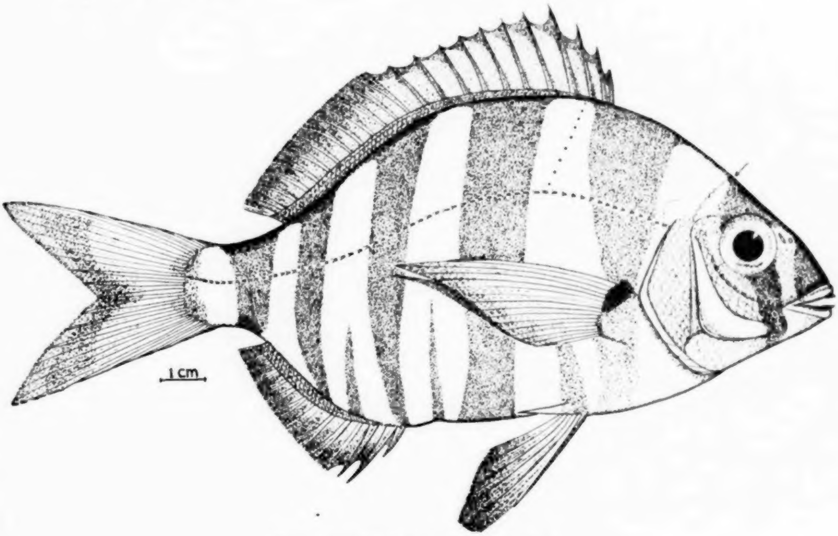

Fig. 11.—*Diplodus trifasciatus* Raf.
The rows of dots show number and disposition of scale rows. The small arrow shows anterior margin of scaling on head.

Genus *Argyrops* Swainson.

1933. Fowler, U.S. Nat. Mus. Bull. 100, vol. xii, p. 143.

Body fairly deep, ovate. Eye moderate. Snout blunt, steep. Mouth small or moderate. Anterior teeth conical, molars in 2 or 3 series in each jaw, no villiform teeth. Dorsal spines 11 or 12, first 2 very short, 3rd elongate, sometimes also 4th to 6th filamentous. Soft dorsal and anal scaly basally.

Scales ctenoid, fairly large on body, not more than 55 series, 7 or 8 above. Preopercle flange naked. Interorbital scaly.

Genotype *spinifer* Forsk.

This genus has not generally been accepted at full rank; and has been regarded as monotypic. *filamentosus* Valenciennes is now also included.

The genus is well worthy of maintenance on the combination of large scales, very short first 2 dorsal spines, filamentous 3rd dorsal spine,

and naked preopercle flange. Fowler (1933, *loc. cit.*, p. 168) proposed *Dulosparus* as a new subgenus of *Sparus* Linn. for *filamentosus* Val. without ever having seen a specimen. Later (Proc. Ac. Nat. Sci. Phil., 1935, vol. lxxxvii, p. 390), when he examined a specimen, he placed it in *Sparus* without mentioning his proposed subgenus. The two species occur in the Indian region, the type extending to the Pacific.

Key to the Species.

I. Four dorsal spines filamentous. Gill-rakers lanceolate . . . *spinifer.*
II. Only the 3rd dorsal spine filamentous. Gill-rakers tubercle-like . . *filamentosus.*

Argyrops spinifer Forsk.

(Pls. XX and XXV.)

1933. Fowler, U.S. Nat. Mus. Bull. 100, vol. xii, p. 143 (References and Synonymy).

This species is so well known and has so often been described that detailed redescription is not necessary. It can hardly be confused with any other species.

Dorsal profile very steep, snout blunt. Depth 1·7–1·9. Eye 3–3·4 in head. 4–6 sharp conical teeth in the front of each jaw. Preorbital deep. Gill-rakers 9–10 on the lower limb of the anterior arch.

D XI–XII, 10–11 : first 2 spines short. 3rd–6th filamentous, in juveniles longer than body, in large adults shorter but still very elongate.

A III, 8 : soft dorsal and anal scaly basally.

Scales ctenoid, rounded; lateral line scales with 2 large pores behind tubes (Pl. XX, fig. 3; Pl. XXV, figs. 1 and 2). l.l. 49–53, l.tr. $\frac{7\text{–}8}{16\text{–}18}$, 5 rows on cheek. Interorbital scaly, scales extend to above hind nostril. Preopercle flange naked.

Reddish or light brown, young with faint cross-bars.

Length.—Up to 600 mm.

Locality.—Natal; extends throughout the Indo-Pacific.

Uncommon in South Africa, but always easily recognisable by the 4 much-elongated dorsal spines, in very young fishes longer than the body. I have examined the type of *Pagrus ciliaris* von Bonde (S.A. Fish. Mar. Bio. Surv. Spec. Rep., No. 1, p. 19, pt. 5, 1923) and it appears to be merely the juvenile form of *spinifer* (confirming the opinion of Barnard, 1927, *loc. cit.*, p. 696).

Argyrops filamentosus Valenciennes.

1933. Fowler, U.S. Nat. Mus. Bull. 100, vol. xii, p. 168 (References).
1935. Fowler, Proc. Ac. Nat. Sci. Phil., vol. lxxxvii, p. 390, fig. 24.

The following description is compiled:—

Depth 2, length of head 3·2 in length of body. Eye 3–3·7, snout 2–2·5, interorbital 2·8 in length of head. Preorbital deeper than eye (in adult). 4 conical teeth in front, and 3 rows of molars in each jaw. 9 gill-rakers on lower limb of anterior arch, short, tubercle-like.

D XII, 10 : first 2 spines minute, 3rd elongate, filamentous, 2·7–3 in length of body, 4th spine fairly long but not filamentous, remainder shorter.

A III, 8: ventral 1·3 in, pectoral 1–1·2 times head.

l.l. 51–54, l.tr. $\frac{6\text{–}7}{14\text{–}15}$, 6 rows across cheek. Preopercle flange naked. Interorbital completely scaly, scaling extends forward well in advance of anterior margin of eye.

Colour reddish, even to fins. Largest recorded size 334 mm.

A rare species, only one specimen taken in South African waters, in North Zululand. Other specimens have been known from the Indian Ocean.

It is possible that this species merits generic distinction from all other Sparid fishes. I have not been able to examine a specimen, but from the description *filamentosus* would appear to be more closely related generically to *spinifer* Forsk. than to any other species.

Genus *Pterogymnus* n.g.

Body ovate, fairly compressed. Eye large, preorbital fairly shallow. Mouth moderate, in front of upper jaw 4, in lower 6 caniniform teeth, the outer pair in each jaw flaring outwards. Molars small, upper biserial. Lips strongly villose. Dentaries cavernous, light. Maxillary bones moderately heavy. Maxilla with acute projecting infero-anterior process, which forms a notch at junction on lower anterior margin of preorbital. Opercular spine concealed. Hind nostril oval. 12 dorsal spines, moderate. 2nd and 3rd anal spines about equal. Soft dorsal and anal naked, with very low sheath. Pectoral about equal to head. Scales moderate, ctenoid; lateral line scales with 2 or 3 large pores behind tubule. Preopercle flange and interorbital completely scaly. Colour reddish.

Genotype *laniarius* Cuvier.

Generally the genotype has been regarded as congeneric with species here placed in *Chrysoblephus* Swainson. Fowler (1933, *loc. cit.*, p. 153) placed it in *Sparus* Linn. Actually *laniarius* merits full generic distinction

from all other Sparid fishes by the combination of outwardly flaring canines, weak biserial molars, naked median fins, scaly preopercle flange and interorbital, and shallow preorbital. Further, the species generally lives in deeper water than most other Sparid fishes.

Pterogymnus laniarius Cuv.

(Pls. XIX and XXV and text-fig. 12.)

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 694, fig. 24 (head).
1933. Fowler, U.S. Nat. Mus. Bull. 100, vol. xii, p. 153.

Body compressed, ovate. Dorsal profile sloping to snout.

Depth 2·3–2·5, length of head 2·8–3·1 in length of body. Eye 3·2–4·0, snout 2·3, interorbital 3·3–3·8, and postorbital 2·6 in length of head.

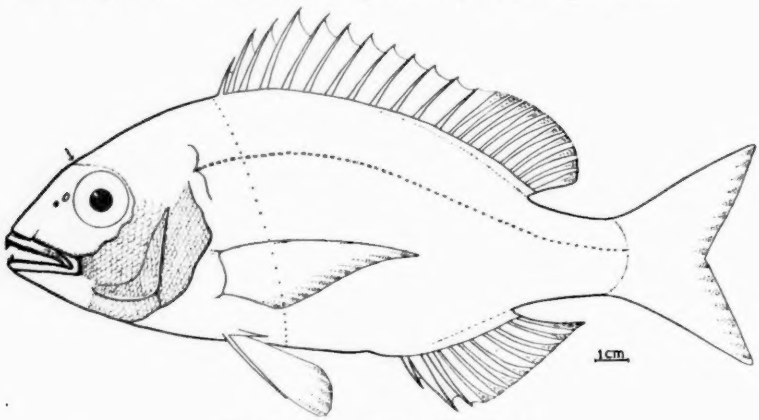

FIG. 12.—*Pterogymnus laniarius* Cuvier.
The rows of dots indicate number and disposition of scale rows. The small arrow shows anterior margin of scaling on head.

Preorbital depth less than eye, almost equal to eye in large adults, lower margin straight, a deep notch between anterior lower angle and projecting inferior maxillary process. Hind margin of preorbital undulate. Posterior nostril oval.

Gill-rakers 12–13, moderate.

Mouth fairly large, maxilla extends below anterior margin of pupil. In upper 4, in lower jaw 6 canines, the outer pair in each jaw strongest and flaring outwards. Molars in 2 series in upper jaw, outer more or less acute in all but largest specimens. Villiform teeth behind symphyses. Lips strongly villose.

D XII, 10 : 4th and 5th spines longest, 2·3–2·4 in head, thereafter graduated shorter, soft rays higher than last spine. A III, 8 : 2nd spine stouter but no longer than 3rd. Pectoral almost as long as head, ventrals 1·6–1·7 in head. Scales moderate, ctenoid (Pl. XXV, figs. 4 and 5). Lateral line scales notched behind, tubule short and stout with several large pores behind (Pl. XIX, fig. 3). l.l. 56–59, l.tr. $\frac{8}{17\text{–}18}$, 9 scales across cheek. Interorbital and preopercle flange scaly; scales on head extend above posterior nostril. Soft dorsal and anal naked, but with low scaly sheath.

Colour.—Light pink-rosy, sometimes with faint longitudinal stripes, white below. Fins pink.

Locality.—From the Cape Peninsula to beyond East London, usually in fairly deep water, down to 60 fathoms. Confined to South Africa.

Length.—Up to 400 mm.

This species has generally been grouped with *gibbiceps* Cuvier and related species, but it certainly merits full generic distinction for reasons given above. It may be noted that it is an exception among Sparine fishes in not coming close inshore in shallow water. Its capture by rock anglers occurs very rarely, if ever. I have never heard of its being taken other than in deep water by line or trawl. *P. laniarius* is of considerable commercial significance.

Barnard's figure (*loc. cit.*, 1927) of the head of this species shows the eye to be less than the preorbital depth, which is erroneous.

This species may easily be identified even when the body has decomposed, or from a skeleton, by the acute maxillary process, the outwardly flaring canines, and the cavernous mandibles. It is probably almost exclusively carnivorous, and is to some extent a connecting link between the Sparidae and the Denticidae; in habits and appearance it resembles the latter, but the skeleton leaves no doubt that it falls in the Sparidae.

Genus *Cymatoceps* n.g.

Body oblong oval, compressed. Eye moderate to small, preorbital deep. Mouth moderate. 4 canines in upper, 4–6 in lower jaw, no villiform teeth. Molars biserial in upper jaw, outer row much the larger, inner small. In juveniles outer molars acute. No villiform teeth. Maxillary bones heavy. Hind nostril oval. 12 dorsal spines, short. 2nd anal spine longer than 3rd. Soft dorsal and anal densely scaly basally. Pectoral shorter than head.

Scales ctenoid, moderate to small, those above the lateral line very much smaller than those below. Lateral line tubes moderate, with a few pores behind. Preopercle flange with a few median series of scales but naked

mostly along ridge and margin. Cheek scales very small. Interorbital scaly, scales on head extend forward well in advance of eye. Colour dusky to black.

Genotype *nasutus* Castlenau, monotypic and endemic. *Cymatoceps* is distinguished from all other Sparid genera by the combination of biserial molars, caniniform anterior teeth, heavy scaling on dorsal and anal fins, partly scaly preopercle flange, scales above lateral line much smaller than those below, and the dark colour of body and fins. It is most closely allied with *Chrysoblephus* Swainson, but the ground colour, only part scaling of the preopercle flange, and the great difference in size between the scales above and below the lateral line, as well as the habits of the type, render generic distinction desirable.

Cymatoceps nasutus Castlenau.

(Pls. XX and XXV and text-fig. 13.)

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 695.
1935. Smith, Rec. Alb. Mus., vol. iv, p. 204, pl. xxii, B.

This characteristic endemic species does not require more than the briefest description. Large adults are immediately recognisable by the large fleshy process, or "Nose," developed on the snout.

At all stadia the scaly soft dorsal and anal are dusky black, as is also generally the dominant ground colour.

Juveniles are not as easily recognised since they differ from the adult in certain features: there is no "Nose," the colour is often dusky brown with sometimes lighter nebulous patches on the sides. Also in juveniles the lateral molars are acute, and only in the adult do they acquire the characteristic smooth rounded crowns.

This species is generally found among rocks, even large specimens often come into quite shallow water.

Depth 2·3–2·5. Eye 4–6 in length of head. Preorbital depth greater than eye. Maxilla extends below anterior part of eye. Canines slender in juveniles, become obtuse in old specimens. Molars in 2 series, outer larger, more or less conical in juveniles.

D XII, 10: spines fairly stout, 3rd–5th subequal, longest, 3 in head. Soft fin anteriorly somewhat elevated. A III, 8: 2nd spine usually longer and stronger. Pectoral 1·1–1·3, ventrals 1·7 in head. Caudal emarginate.

Scales ctenoid, those above the lateral line very much smaller than those below (Pl. XXV, figs. 3 and 8). Lateral line tubes moderate, with one or two pores behind (Pl. XX, fig. 5). l.l. 61–65, l.tr. $\frac{11\text{–}12}{21\text{–}24}$, 16 cheek scales.

Preopercle limb scaly only down median portion. Interorbital scaly; scaling extends forward above anterior nostril. Soft dorsal and anal densely scaly basally.

Colour.—Dusky to black. Soft dorsal and anal black, and ventrals also in half-grown fishes.

Locality.—Cape Peninsula to Natal. Specimens over 100 lbs. in weight not uncommon.

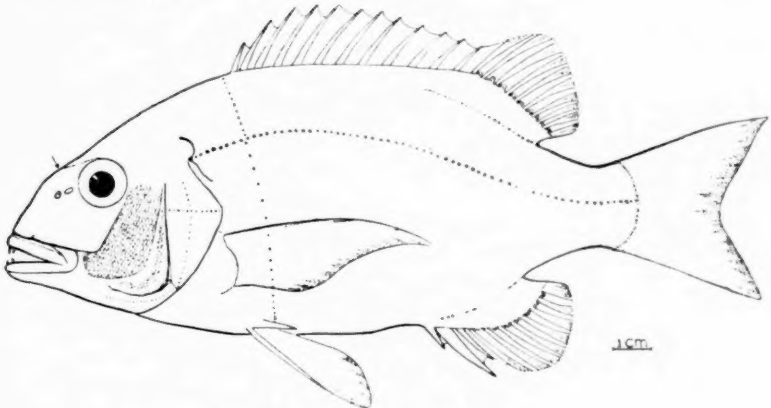

FIG. 13.—*Cymatoceps nasutus* Cast. (Juv.)
The rows of dots represent number and disposition of scale rows. The small arrow indicates the anterior margin of scaling on head.

nasutus is more or less omnivorous and is the largest of all the Sparid fishes in South Africa, where it is esteemed by anglers as a sporting fish.

It does not enter estuaries save under exceptional circumstances.

Genus *Chrysoblephus* Swainson.

Body fairly deep, moderately to greatly compressed. Eye moderate, preorbital fairly deep. Mouth moderate, 4–6 canines in each jaw, usually with villiform teeth behind. Molars in 3 or more series in each jaw, outer row larger than inner, usually acute in juveniles. Hind nostril oval or slit-like.

Twelve dorsal spines, moderate or strong, sometimes elongated but not longer than head. 2nd anal spine not much longer than the 3rd. Soft dorsal and anal densely scaly basally. Pectoral usually longer than head.

Scales ctenoid, more or less rounded, moderate to small, 50–65 series,

those above the lateral line not much smaller than those below. Lateral line tubes stout and short, oblique, with several pores behind tubes. Preopercle flange completely scaly. Cheek scales moderate. Interorbital scaly, scaling on head well in advance of front eye margin. Colour pinkish or reddish, sometimes with faint darker red cross-bars.

Genotype *gibbiceps* Cuvier.

This genus has not hitherto been accepted at its full rank. Barnard (Ann. S.A. Mus., 1927, vol. xxi, p. 692) did not even accept the designation of *gibbiceps* as genotype as valid, since he regarded the description of the dentition (by Swainson) as erroneous. Actually that definition is somewhat ambiguous, but may easily be applied to *gibbiceps*. Most other workers have accepted that species as the genotype of *Chrysoblephus*, but have recognised the latter as worthy of only subgeneric rank at best. Fowler, *e.g.* (*loc. cit.*, 1933, p. 147), has placed it as a subgenus of *Sparus* Linn.

In the course of the present work it has been obvious that the species here placed in *Chrysoblephus* definitely merit generic distinction from all other Sparid fishes. Whether or no an examination of the precise terms of Swainson's diagnosis will ultimately establish *Chrysoblephus* I cannot determine, not having access to the original text. It has been decided to accept *Chrysoblephus* as of valid definition.

The dominant red colour, the molars in 3 or more series, the anterior canines, the scaly dorsal and anal fins, scaly interorbital and preopercle flange, and general habits all combine to establish the validity of the genus.

Hitherto there have been accepted only four species of *Chrysoblephus* (as here defined), viz. *gibbiceps* Cuv., *anglicus* G. & T., *laticeps* Cuv., and *cristiceps* Cuv. Gilchrist and Thompson (Ann. S.A. Mus., 1908–11, vol. vi, p. 173) described a Natal species as *puniceus* G. & T., but most later workers of repute have accepted Barnard's opinion (*loc. cit.*, 1927, p. 700) that *puniceus* was a synonym of *cristiceps*. A re-examination of the type of *puniceus*, and complete specimens of that species, has shown it to be valid and clearly distinct from *cristiceps*.

Also Fowler (Proc. Ac. Nat. Sci. Phil., 1925, vol. lxxvii, p. 234, fig. 3) described a Natal fish as *Sparus lophus* n. sp., which was not accepted, and has since been regarded as a synonym of *gibbiceps* Cuv. A specimen recently to hand from Natal shows that *lophus* may be accepted as valid.

There are thus six species in the genus, and all frequent moderately to fairly deep water on rocky ground. They are typically marine and do not enter estuaries in normal circumstances. Some are of considerable economic significance, and are mostly taken on lines from boats in 5–40 fathoms. They are caught by shore anglers only where the water deepens rapidly.

Key to the Species.

I. Profile of snout sloping. Forehead very broad (not gibbous) with a dark (blue) transverse band . . . . *laticeps.*

II. Profile of snout moderately steep. Nape sharp, never gibbous. No cross-bars.
- A. l.l. 59–61. 9–10 gill-rakers . . . . *cristiceps.*
- B. l.l. 49–52. 14–15 gill-rakers . . . . *puniceus.*

III. Profile of snout very steep. Nape gibbous. Usually faint cross-bars.
- A. l.l. 53–58. Scales on cheek with a forward patch below eye.
  - X. Scales on cheek extending well in advance of above hind margin of maxilla. 3rd dorsal spine not longer than 1·5 in head . . . . *gibbiceps.*
  - Y. Scales on cheek not extending in advance of above hind margin of maxilla. 3rd dorsal spine almost to full length of head . . . . *lophus.*
- B. l.l. 63–67. Scales on cheek obliquely back from corner of mouth without forward patch below eye . . . . *anglicus.*

Chrysoblephus laticeps Cuv.

(Pls. XIX and XXVI.)

1927. Barnard, *loc. cit.*, p. 701 (References and Synonymy).

This well-known and plentiful species does not require detailed redescription. It may easily be distinguished from the other species of the genus by the sloping profile, by the shallower body, and by the coloration. The interorbital and nape are broad and convex.

Depth 2·3–2·5. Eye 3·3–4·5 in head, greater than (juv.) to slightly less than (ad.) preorbital depth. Gill-rakers 10.

D XII, 10 (abnormally XI, 11); A III, 7–9.

Scales ctenoid, radiating striae few (Pl. XXVI, figs. 1 and 2). Lateral line tubes very short and stout, with two large pores behind (Pl. XIX, fig. 5). l.l. 58–61, l.tr. $\frac{9\text{–}10}{19\text{–}21}$, 12–14 rows on cheek. Scaling on head extends above nostrils. Soft dorsal and anal densely scaly at base.

Orange or reddish, shading paler below, head usually brilliant orange. A blue bar across the interorbital (darkens on preservation). Usually a more or less triangular light patch on the side of the body, fades out with preservation, larger in juveniles. Pectoral axil darkish. Fins rosy, often with bluish tinge in ventrals. A blue colour variety is known from the Cape, but the light patch on the side is present.

Extends from the Cape through Natal to Zanzibar and Mauritius.

This characteristic species is well known all along the South African coast and is generally taken where the water is not too shallow. It is generally known as "Roman" or "Red Roman," and at times is caught in

large numbers, the average being 1½–2 lbs. in weight, though specimens 18 inches in length have been taken. The flesh is palatable, though in certain localities it is rather rank.

Chrysoblephus cristiceps Cuv.

(Pls. XX and XXVI and text-fig. 14.)

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 700.

Dorsal profile elevated, steeply sloping and undulate, large concavity from above eye to snout tip. Nape fairly sharp.

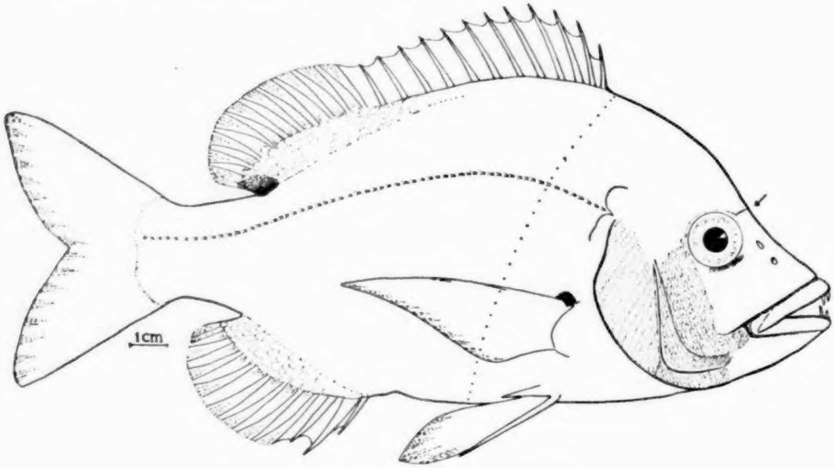

Fig. 14.—*Chrysoblephus cristiceps* Cuv.
The lines of dots represent number and disposition of scale rows. The small arrow indicates anterior margin of scaling on head.

Depth 2·2–2·3, length of head 2·8–3·0 in length of body. Eye 3·6–6·0, snout 2·3–2·5, interorbital 3·5–3·7, and postorbital 2·5 in length of head.

Preorbital depth 1·1–1·3 times eye; lower margin of preorbital almost straight. Gill-rakers 9–10 on lower limb of anterior arch. Maxilla extends below hind nostril or farther, not to eye margin; extremity well exposed. Anterior canines large. Lateral molars acute in juveniles, more rounded in adults, much larger than inner series.

D XII, 10: spines fairly stout, 4th and 5th longest, 2·3–2·5 in head, edge of soft fin rather convex. A III, 8: soft fin similar to dorsal. Pectoral 1·0–1·2 in head. Ventrals 1·5 in head.

Scales ctenoid (Pl. XXVI, figs. 3 and 8). Lateral line tubes moderate

with two pores behind (Pl. XX, fig. 2). l.l. 59–61, l.tr. $\frac{9\text{–}10}{19\text{–}20}$, 11 cheek scales. Interorbital scaly, scaling on head extends to slightly in advance of eye. Preopercle flange completely scaly.

Colour.—Reddish, variegated with golden and blue reflections from the scales. Faint blue bar below orbit; hind margin of opercle and scapular scaling bluish. A dark spot in pectoral axil, and a black spot with dusky to blue shading above at base of last dorsal rays. The play of colour over the body of this species immediately preceding and just after death is beautiful almost beyond description; waves of colour, blue, green, bronze, orange, and red, alone and intermingled, sweep over the body and continually surge up and die away.

Length.—Up to 630 mm.

Locality.—Cape Peninsula, chiefly Agulhas Bank, and eastwards to Natal. Most plentiful along the south coast of South Africa.

A very characteristic species, of considerable economic significance, occurring in large numbers from False Bay to East London; the flesh is generally highly esteemed. *cristiceps* is a rare capture from the shore, save where the land dips sharply to deep water. Usually the "Dageraad" is taken on banks in 10–50 fathoms.

As mentioned by Barnard (*loc. cit.*, 1927) the body shape changes somewhat with age; the nape becomes elevated and the body more or less triangular in large adults.

Chrysoblephus puniceus Gilchrist and Thompson.

(Text-fig. 15.)

1908. Gilchrist and Thompson, Ann. S.A. Mus., vol. vi, p. 173.
1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 700 (*cristiceps* part).

Dorsal profile of snout very steep, almost straight from nape. Nape very sharp, with a ridge before the dorsal fin.

Depth 2–2·1, length of head 3·3–3·4 in length of body. Eye 3·6 (juv.)–4·0, snout 2·4–2·6, interorbital 3–3·6, and postorbital 2·7 in length of head.

Preorbital depth slightly less than (juv.) to slightly more than eye diameter. 14–15 gill-rakers on lower limb of anterior arch. Maxilla extends to below anterior margin of eye, extremity almost covered. Anterior canines moderate. Lateral molars somewhat acute even in larger specimens.

D XII, 10: spines slender, 3rd and 4th longest, subequal, 2·0–2·1 in head, edge of soft fin gently convex. A III, 8: soft fin similar to dorsal. Pectoral 1·2–1·3 times head. Ventrals 1·2–1·3 in head.

Scales ctenoid; lateral line tubes moderate, with two pores behind. l.l. 49–52, l.tr. $\frac{10}{18}$, 8–9 cheek scales. Interorbital scaly, scaling on head extends to above anterior nostril. Preopercle flange completely scaly.

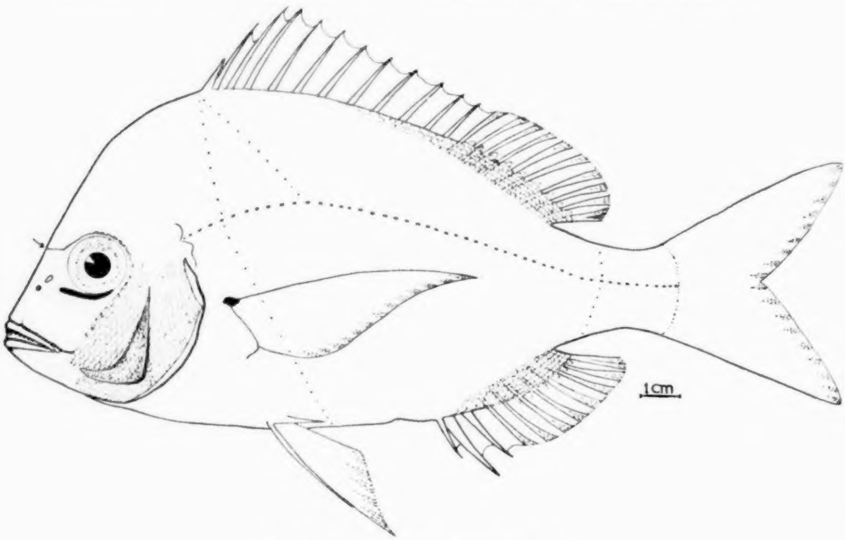

FIG. 15.—*Chrysoblephus puniceus* G. & T.
The lines of dots represent number and disposition of scale rows. The small arrow indicates anterior margin of scaling on head.

Colour.—Reddish with blue reflections. A blue bar below eye. Fins rosy.

Length.—Up to 350 mm.

Locality.—Natal and Zululand coasts.

This species has for some years been accepted as conspecific with *cristiceps* Cuv. Actually it is clearly distinct, as the following table shows:—

	cristiceps.	*puniceus.*
Depth in length . .	2·2	2·0
Head in length . .	2·8–3·0	3·3–3·4
l.l.	59–61	49–52
Pectoral with head . .	1·0–1·2 in.	1·2 times
Gill-rakers . . .	9–10	14–15

Also there are other differences: e.g. *cristiceps* always has the dark spot at the base of the last dorsal ray, and only a faint bar below the eye, while the snout profile is concave before the eyes; *puniceus* has no dark dorsal spot, but the bar below the eye is heavy and the snout profile is almost straight.

It is indeed peculiar to find two fishes so closely related as *cristiceps* and *puniceus* so sharply divided in their distribution in a relatively restricted area. *puniceus* is certainly rare, if known at all, west of the Great Kei mouth, while *cristiceps*, so abundant west of East London, is a very rare capture in Natal waters.

It may be remarked that Mr. Bell Marley, to whom reference has earlier been made, has always maintained that *puniceus* was a valid species, but has not hitherto been able to have his opinion confirmed.

Chrysoblephus gibbiceps Cuv.

(Pls. XIX and XXVI.)

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 698, fig. 25 *b* (head) (part).

Snout profile very steep, almost vertical, concave between snout tip and nostrils, a bulge at interorbital which is generally pitted or spongy, increasingly so with age. Snout fairly sharp, somewhat pointed. The nape, probably only in males, becomes gibbous and prominent, a large "forehead" protruding. Depth 2·15–2·4, length of head 2·9–3·2 in length of body. Eye 3·5–4·5, interorbital 3·1–3·3, snout 2·1–2·3, and postorbital 2·1 in length of head. Eye 1·0(juv.)–1·6(ad.) in preorbital depth. Mouth moderate, maxilla extends to below anterior third of eye or to below pupil. Canines moderate, subvertical. Outer molars largest, 4–5 series in each jaw. 11–12 gill rakers on lower limb of anterior arch.

D XII, 10 (rarely XI, 11): spines graduated, 1st 5·4–6·8, 2nd 3·0–3·5, 3rd 2·0–2·5, 4th 2·0–2·4 in head, remainder graduated shorter. Soft fin evenly convex, longest ray 2·8–2·9 in head. Base of dorsal 1·4–1·5 in body length.

A III, 8: inserted below origin of soft dorsal. 2nd spine longest 3·3–3·5 in head. Edge of soft fin evenly convex, longest ray 2·8–2·9 in head.

Pectorals 1·0–1·1 in head, reach to above origin of soft anal. Ventrals 1·6–1·7 in head, do not reach beyond vent.

Scales ctenoid (Pl. XXVI figs. 4 and 5). Lateral line tubes large, with two pores behind (Pl. XIX, fig. 6). l.l. 52–55, l.tr. $\frac{9\text{–}10}{18\text{–}19}$. Cheek scaling with a forward extension of smaller scales along the middle of the preorbital below the eye, the anterior margin of the scaling extending well forward of above the hind margin of the maxilla. 10–11 scales from the

preopercle ridge to preorbital margin, 24–25 series in all on cheek. Scales on head extend above anterior nostril: from the front the scaling reaches down to the level of the centre of the eye. Preopercle flange scaly.

Colour.—Patchy white to pink, often with scattered darkish spots. Light reddish above with 6 or 7 darker red cross-bars, which fade on preservation.

Length.—Up to 500 mm.

Locality.—False Bay to Algoa Bay, usually in deeper water, up to 50 fathoms; Agulhas Bank.

A very characteristic species, plentiful in the False Bay area, progressively much scarcer eastwards. Large specimens with the strongly gibbous nape have a rather singular appearance.

Fowler (U.S. Nat. Mus. Bull. 100, 1933, vol. xii, p. 165) accepts records of *gibbiceps* from Australia.

Chrysoblephus lophus Fowler.

1925. Fowler, Proc. Ac. Nat. Sci. Phil., vol. lxxvii, p. 234, fig. 3.

Snout profile very steep, subvertical, concave between snout tip and nostrils, a prominent bulge at interorbital which is wrinkled and spongy. Snout rather sharp, almost rodent-like, protrudes.

Depth 2·17, length of head 3·0 in length of body. Eye 3·9, snout 2·2, interorbital 2·9, and postorbital part of head 2·2 in length of head. Eye 1·1 in preorbital depth (1·0 in *gibbiceps* of equivalent size). Mouth moderate, maxilla extends below front margin of eye. Canines moderate, somewhat oblique, outer molars far the largest. Inner molars in bands, irregularly spaced, about 5 series in each jaw. 10 gill-rakers on the lower limb of the anterior arch.

D XII, 10: 3rd–5th spines abruptly differentiated forming a crest. 1st spine 7·8, 2nd 4·3, 3rd 1·04, 4th 1·3, 5th 1·7 in head; remainder graduated shorter. Soft fin evenly convex, longest ray 2·4 in head. Base of dorsal 1·6 in body length.

A III, 9: inserted below origin of soft dorsal. 2nd spine longest, 3·1 in head. Longest soft ray 2·7 in head. Pectorals 1·2 times head, 2·5 in length of body, reach beyond soft anal origin. Ventrals 1·5 in head, reach beyond vent.

Scales ctenoid, lateral line tubes stout with several pores behind, very like those of *gibbiceps* Cuv. l.l. 58, l.tr. $\frac{9}{18}$. Cheek scaling with a forward extension of smaller scales along the preorbital, the anterior margin of the scaling does not extend forward beyond above the hind margin of the maxilla: 8 or 9 scales from preopercle ridge to hind margin of preorbital, 15 series in all on cheek. Scales on head extend above anterior nostril:

from the front the scaling reaches down to the level of just below the upper margin of the eye. Preopercle flange scaly.

Colour (preserved).—Light brown, probably reddish in life. Oblique rows of small indistinct dusky spots above the lateral line anteriorly, sloping down to cover most of the caudal region. A dark bar across the interorbital, possibly blue in life.

Length.—260 mm.

Locality.—Natal.

Fowler's description of the type of *lophus* is rather inadequate in so far as the establishment of the validity of the species is concerned, and Barnard's refusal to accept *lophus* in the absence of the type or of a typical specimen was fully justified. My experience that Natal forms have so often proved distinct from those of the Cape has led me to seek a specimen corresponding with that described by Fowler. I have been fortunate in receiving one from Dr. Lawrence, Director of the Natal Museum, which agrees in most particulars with Fowler's description. Comparison with specimens of *gibbiceps* has shown that *lophus* is most probably a valid species, although most extraordinarily closely related to *gibbiceps*. *lophus* is distinguished chiefly by the nature of the scaling on the cheek (the forward patch does not extend nearly as far towards the snout as in *gibbiceps*), as well as by the greater length of the fins, notably the very elongate 3rd and 4th dorsal spines. The spines of *gibbiceps* are sometimes elongate, but there is never the abrupt differentiation of the anterior spines from the others as in *lophus*. Also *lophus* differs from *gibbiceps* in having a dark transverse interorbital bar, a deeper preorbital, a wider interorbital, more scales, and an extra anal ray. The anterior canines of *lophus* appear to be more oblique than those of *gibbiceps*.

Apparently only two specimens of *lophus* have ever been taken—the type (unfortunately in America, and so inaccessible) and the one described above. The case of *gibbiceps* and *lophus* resembles that of *cristiceps* and *puniceus* in this genus.

Chrysoblephus anglicus Gilchrist and Thompson.

(Pls. XIX and XXIV and text-fig. 16.)

1908. Gilchrist and Thompson, Ann. S.A. Mus., vol. vi, p. 172.

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 700, fig. 25 *a* (head).

Dorsal profile of snout almost vertical, not or scarcely concave. Nape slopes gently to interorbital. Depth 2·3–2·5, length of head 3·2 in length of body. Eye 3·5–4·7 in head, 1·1(juv.)–2 in depth of preorbital. Snout very blunt. Canines moderate, outer molars largest, 4–5 inner series. (No gills in any specimens examined.)

D XII, 10: 3rd and 4th spines longest, 1·5–1·7 in head. A III, 8. Pectoral 1·1–1·2 times, ventral 1·4 in head. Scales ctenoid (Pl. XXIV, figs. 3 and 8). Lateral line tubes very oblique, with two diverging series of pores behind (Pl. XIX, fig. 4). l.l. 65–68, l.tr. $\frac{10\text{–}11}{23\text{–}25}$, 11–12 scales on cheek, no forward patch below eye. Interorbital scaly, scaling on head extends above posterior nostril. Preopercle flange scaly.

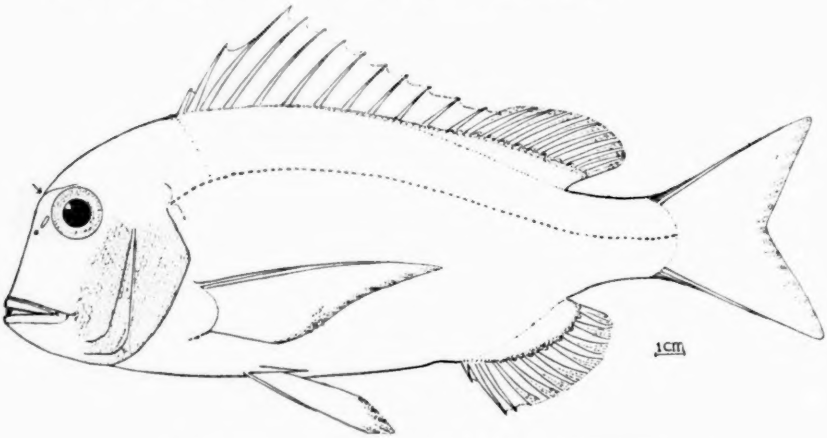

FIG. 16.—*Chrysoblephus anglicus* Gilchrist and Thompson.
The rows of dots indicate the number and disposition of the scale rows. The small arrow shows the anterior margin of scaling on head.

Colour.—Reddish, lighter below, with several darker red cross-bars, which disappear with preservation. A reddish stripe at pectoral base. Rows of spots on the scales above the lateral line.

Length.—Up to 470 mm.

Locality.—Natal coast.

This is a peculiar species, apparently confined to a restricted area. It is not known south of Natal, and may eventually prove to extend along the east coast of Africa northwards. It is the most easily identifiable Sparine fish, the shape of the head being immediately characteristic. It is nowhere very plentiful.

Genus *Porcostoma* n.g.

Body ovate, fairly robust. Snout subconical. Eye small. Preorbital deep, completely concealing maxilla. Posterior nostril small, circular.

Mouth moderate, in upper 4, in lower jaw 6 prominent projecting canines, visible when mouth closed; behind those villiform teeth. Molars in 2–3 series in each jaw, sometimes 4 series above.

Thirteen dorsal spines, short. Soft dorsal and anal densely scaly for basal $\frac{1}{3}$–$\frac{1}{2}$. Caudal only slightly emarginate.

Scales small, ctenoid, almost quadrangular, more than 70 series. Preopercle flange only partly scaly along inner margin of flange. Cheek scales small; interorbital scaly, scaling on head to in advance of front eye edge.

Genotype *dentata* Gilchrist and Thompson.

It is remarkable that this peculiar species should ever have been included in either *Pagrus* Cuv. or *Sparus* Linn. It is clearly distinct by full generic rank from all other Sparid fishes. The combination of concealed maxilla, small scales of characteristic shape, 13 dorsal spines, projecting canines, scaly interorbital, circular hind nostril, and almost naked preopercle flange places it by itself.

The genus is endemic and monotypic.

Porcostoma dentata G. & T.

(Pls. XX and XXV and text-fig. 17.)

1908. Gilchrist and Thompson, Ann. S.A. Mus., vol. vi, p. 173.
1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 697.

This species is always very easily identified by the combination of concealed maxilla, projecting canines, 13 dorsal spines, and few scales on preopercle flange. It merits no more than the briefest redescription.

Depth 2·4–2·5, head 3·1–3·2 in body length. Eye 3·7–4·2 in head, 1·5–1·8 in preorbital depth. 4 canines in upper, 6 in lower jaw, villiform teeth behind those. 11–12 gill-rakers. Hind nostril circular, small.

D XIII, 11: 4th and 5th spines longest, 3·2 in head. A III, 8–9: 2nd and 3rd spines subequal. Pectoral equal to head. Ventral 1·8 in head. Caudal with broad round lobes, only gently emarginate.

Scales small, ctenoid. Lateral line tubes very short, stout, with 2–3 tubes behind (Pl. XX, fig. 4). Most body scales sub- or fully quadrangular (Pl. XXV, figs. 6 and 7). l.l. 71–73, l.tr. $\frac{15}{26}$, 9–10 across cheek. Interorbital scaly, scaling on head extends above anterior nostril. Preopercle flange mostly naked, only a few scales along inner margin.

Colour.—Reddish, lighter below, sometimes streaks along the scale rows. A dark bar across the interorbital. The first 8–12 lateral line scales dark, forming a streak. Soft dorsal and anal, pectorals and ventrals with golden tinge.

Length.—Up to 270 mm.

Locality.—Natal to Delagoa Bay, usually in deeper water.

A comparatively scarce species, found in a fairly restricted area.

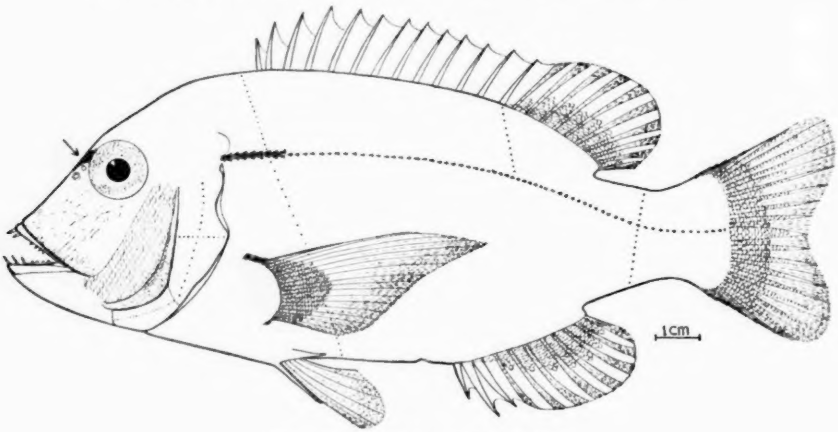

FIG. 17.—*Porcostoma dentata* G. & T.
The rows of dots represent number and disposition of scale rows. The small arrow shows the anterior limit of scaling on head.

Subfamily PAGELLINAE.

Molariform teeth weak but always present. Anterior teeth slight and conical, forming outer series of a band of villiform teeth. Dentition rapto-tritorial but relatively feeble. Mouth small, but rather to very protractile. Premaxillary rami about as long as pedicels. Scales ctenoid. Interorbital naked or scaly. Preopercle flange naked.

Eye moderate to large. Posterior nostril oval or slit-like.

11 or 12 dorsal spines. Soft dorsal and anal naked with low sheath. Caudal deeply forked.

Colour either reddish to bronzy, or else silvery with dark cross-bars.

More or less carnivorous (food chiefly mollusca and crustacea) fishes, most living in shallow, one species normally in deeper water.

Three genera are included here, although *Boopsoidea* Cast. shows considerable divergence from the other two. Nevertheless the type and the nature of the dentition and the protractile mouth fit better with the Pagellinae than with the Sparinae.

The species in this group are not of much commercial significance, but one (*Lithognathus lithognathus* Cuv.) ranks high among game fishes and attains a considerable size.

Key to the Genera of the Pagellinae.

I. Eye large, greater than snout. Molars uniformly small . . . *Boopsoidea.*
II. Eye moderate, not greater than snout. Inner molars enlarged.
  A. Interorbital scaly. 12 dorsal spines. Last dorsal and anal ray enlarged. Posterior nostril circular. Scales with lobate hind margin. Preorbital shallow, notched. Pink or red. Inhabit deep water . . . . *Pagellus.*
  B. Interorbital naked. 11 dorsal spines. Last dorsal and anal ray not enlarged. Posterior nostril slit-like. Scales with rounded hind margin. Preorbital deep, not notched. Silvery, with dark cross-bars. Inhabit shallow water . . . . . *Lithognathus.*

Genus *Boopsoidea* Castlenau.

1933. Fowler, U.S. Nat. Mus. Bull. 100, vol. xii, p. 169.

Body fairly deep, compressed. Eye large, greater than snout and than shallow preorbital. Hind nostril oval. Mouth small, snout fairly blunt Sharp conical (villiform) teeth in bands in both jaws, with outer series somewhat enlarged. Small even molars in 2–3 series in each jaw. 11 dorsal spines; soft dorsal and anal naked with low sheath.

Scales moderate, ctenoid. Interorbital and preopercle flange naked. Colour rosy-bronze, scales with darker edges.

Genotype *inornata* Cast.: monotypic and endemic.

Boopsoidea inornata Castlenau.

(Pls. XXII and XXVIII.)

1933. Fowler, *loc. cit.*, p. 169.

This species does not need detailed redescription. Depth 2·1–2·2, head 3·3 in body length. Eye 2·4–2·7, much greater than very shallow preorbital, and greater than snout. Mouth small, protractile; outer series of teeth slightly larger than inner, slight and caniniform. Gill-rakers 13–14, slender. Air-bladder with small caudal extensions. D XI, 10: spines slender. A III, 11. Pectoral slightly longer than head. Ventral 1·7 in head. Caudal forked. Lateral line tubes very broad (Pl. XXII, fig. 1). Scales ctenoid (Pl. XXVIII, figs. 3 and 6). l.l. 53–56, l.tr. $\frac{8\text{–}9}{15\text{–}16}$, 10–11 rows on cheek. Interorbital naked, scales on head extend to above hind margin of eye. Preopercle flange naked.

Colour.—Bronzy with rosy reflections, lighter below. A brownish blotch on opercle above. Axil of pectoral darkish.

Length.—Up to 300 mm.

Locality.—Cape Peninsula to Natal in shallow water.

This is a characteristic species which appears worthy of generic distinction from all other Sparid fishes. The dentition, large eye, shallow preorbital, and short snout set it apart.

Inornata is generally found in moderate to deepish water among rocks or reefs, and in many localities it occurs in vast numbers. The combination of small mouth and voracious appetite renders this species a pest to anglers, since it is impossible to keep any bait intact for any time when numbers of them are about, and they may be caught only on the very smallest hooks.

Genus *Pagellus* Cuv.

1933. Fowler, U.S. Nat. Mus. Bull. 100, vol. xii, p. 171 (part).

Body elongate, not much compressed. Eye moderate, less than snout. Hind nostril circular. Mouth moderate, snout subconical. Outer conical teeth moderate, form outer series of band of 4–5 rows. Molars biserial, inner posterior larger. Mouth moderately protractile. Preorbital shallow, notched. 12 dorsal spines, fairly slender. Soft dorsal and anal naked, with low sheath.

Scales with lobate hind margin (Pl. XXIX, figs. 1 and 2), ctenoid, moderate. Lateral line tubes very short and wide with two open tubules behind. Interorbital scaly. Preopercle flange naked. Pinkish, with or without cross-bars of deeper hue, but not black or dusky.

Regional genotype (South Africa) *natalensis* Steindachner.

Smallish fishes inhabiting fairly deep water and but rarely entering estuaries.

Generally the species here assigned full generic rank in *Lithognathus* Swainson have been included in *Pagellus* Cuv. It is remarkable that the two groups should ever have been accepted as congeneric, and it is time that Swainson's perfectly valid genus received recognition.

Pagellus natalensis Steindachner.

(Pls. XX and XXIX and text-fig. 18.)

1933. Fowler, *loc. cit.*, p. 172 (References and Synonymy).

Body elongate, fusiform, fairly compressed. Dorsal profile of snout low, with moderate concavity before eyes. Adults sometimes with slight frontal gibbosity. Depth equal to length of head, 2·7–3·1 in length of body. Eye 3–4·1, snout 3, interorbital 3·8–4·1, and postorbital 2·6 in length of head. Eye 1·5–2 times depth of preorbital. Preorbital with notched or emarginate lower margin, maxilla well exposed. Posterior nostril small, circular, high up on snout, nostrils close together. Gill-rakers 10–12 on lower part of anterior arch, slender, about 2 in gill-filaments,

which are 1·6 in eye. Mouth moderate, maxilla extends below anterior border of eye. Anterior caniniform teeth very small, 10–12 in lower jaw, outer teeth larger. Molars moderate, biserial. Jaws only moderately protractile. Margin of preopercle serrate in young, serrae concealed in half-grown and adult stadia.

D XII, 10: inserted behind hind margin of operculum. 3rd–5th spines subequal, or 4th, or 4th and 5th, subequal, longest, 2·9 in head; remainder

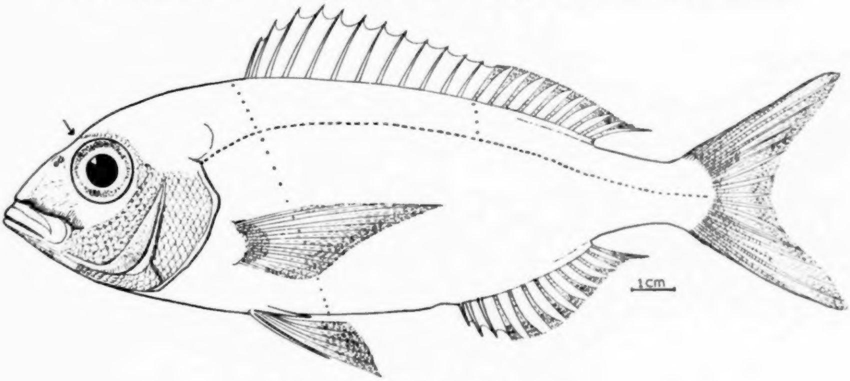

FIG. 18.—*Pagellus natalensis* Stdnr.
The rows of dots represent the number and disposition of scale rows. The small arrow shows the anterior margin of scaling on head.

decrease to the last. First ray but slightly longer than last spine. Edge of soft fin only slightly convex. Last ray enlarged, 3·5 in head, 1·5 times penultimate, reaches almost to caudal base.

A III, 10: 2nd and 3rd spines about equal, shorter than soft rays. Margin of anal fairly convex, 3rd ray longest. Last ray enlarged, about equal to last dorsal ray. Pectoral 1·0–1·1 in head, tip reaches almost above anal origin. Ventrals 1·6–1·7 in head, do not reach vent. Caudal deeply forked, almost lunate, lobes slender.

Scales ctenoid, with lobate hind margin (Pl. XXIX, figs. 1 and 2). Lateral line scales with short wide tube and two tubules behind, each opening by a pore (Pl. XX, fig. 1). l.l. 63–67, l.tr. $\frac{6\text{–}7}{15\text{–}17}$, 6 series across cheek, 7–8 across opercle. Soft dorsal and anal naked, with low scaly sheath. Preopercle flange naked. Interorbital partly scaly; scaling on head extends to above anterior border of eye.

Colour.—Pink or red, lighter below. Sometimes dusky spots above lateral line. Fins rosy.

Length.—Up to 350 mm.

Locality.—Mossel Bay to Madagascar, usually in deep water, up to 75 fathoms.

Not a very common species, but occasionally taken in fair numbers by trawlers on the south coast. Usually does not come close inshore. In the Knysna area, during the summer months, a cold current (50° F.) occasionally comes inshore, and innumerable fishes are numbed and driven ashore. Among the first to appear in the shallow water is *P. natalensis*, sometimes in large numbers.

One specimen from Knysna has a red-brown lateral stripe from above the pectoral base to the caudal peduncle. It is otherwise indistinguishable from other specimens.

Genus *Lithognathus* Swainson.

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 705 (part).
1933. Fowler, U.S. Nat. Mus. Bull. 100, vol. xii, p. 171 (part).

Body fairly elongate, moderately compressed. Snout long, more or less pointed. Eye rather small, less than snout. Hind nostril slit-like. Conical teeth small (markedly smaller than in *Pagellus*), outer series but little enlarged. Molars biserial smallish, inner posterior larger. Mouth very protractile. Preorbital deep, curved, but not notched.

Eleven dorsal spines, fairly stout. Soft dorsal and anal naked, with low sheath. Scales with rounded hind margin (Pl. XXIX, figs. 3 and 6), ctenoid; lateral line tubes short and wide with many pores behind. Interorbital and preopercle flange naked. Silvery with dark cross-bars.

Genotype *lithognathus* Cuv., endemic.

This genus has not been accepted at full rank. Fowler (*loc. cit.*, 1933) assigned it subgeneric rank in *Pagellus*. Actually there can be no question of its validity. Not only is it distinct from *Pagellus* by constant variation in the naked interorbital, slit-like nostril, the character of the scales, and highly protractile mouth, but in general appearance there is a clear-cut distinction. In colour, habits, and habitat these two genera show wide variation. *Lithognathus* is silvery, lives in comparatively shallow water, and regularly enters and lives in estuaries, feeding chiefly upon small crustacea and mollusca found on mud and sand-banks. *Pagellus* is reddish with faint darker red cross-bars, and rarely ever comes close inshore. The mouths in the two genera are quite different. In *Lithognathus* the mouth has been adapted to rooting in the mud and to the blowing of burrowing crustacea from their holes; the dentition is extremely feeble. In *Pagellus* the mouth is more normal, and the dentition, while weak, is obviously raptorial, and better developed than in *Lithognathus*.

Two species are found in South Africa, one of which is endemic.

Key to the Species.

I. 7 wide cross-bars. 8 anal rays. Lips thick . . . . . *lithognathus.*
II. 14 narrow cross-bars. 10 anal rays. Lips moderate . . . . *mormyrus.*

Lithognathus lithognathus Cuv.

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 705.

This well-known species does not require detailed redescription.

Depth 2·7–3, eye 3(juv.)–7 (ad.), much less than preorbital depth in adults. Snout pointed, lips very thick in adults, mouth very protractile. Teeth small, inner molars largest. 12–14 gill-rakers. D XI, 10; A III, 8. Pectorals 1·4–1·5, ventrals 1·8 in head. Caudal forked. Scales large with rounded free margin, ctenoid. Lateral line tubes moderately long and fairly slender; no pores behind. l.l. 44–51, l.tr. $\frac{5\text{–}6}{13\text{–}15}$, 7–8 rows on cheek. Interorbital naked; scaling on head extends above hind margin of eye, not into the interorbital. Preopercle flange naked.

Colour.—Silvery in all but large adults, which become dusky above, deepening on preservation. 6–7 dark cross-bars visible on fresh specimens in all stadia, but become obsolete in large specimens with preservation. Fins silvery grey.

Length.—Attains a length of 1200 mm. and a weight of over 40 lbs.

Locality.—All round the coast of South Africa from north of Walfisch Bay round the Cape to Natal. Common in all estuaries of the southern part of South Africa.

This is the only member of the Pagellinae of any commercial significance in South Africa. It is seldom taken in large numbers, since the larger fishes appear to be of solitary habit; but fair numbers are at times taken by drag-nets in estuaries. The flesh is usually highly esteemed, being of delicate texture and flavour.

As an angling fish *lithognathus* ranks high in South Africa, and may indeed be classed among the best game fishes of the world and is eagerly sought by anglers.

The long snout and thick lips of *lithognathus* have obviously been produced in response to a special method of securing food, in search of which *lithognathus* penetrates to absurdly shallow water. Certain crustacea construct U-shaped burrows in the mud and sand-banks in estuaries. By blowing vigorously down one limb, one may cause the creature to be expelled forcibly up from the other. The "steenbras" evidently secures food in this manner, and quite frequently the tails of very large fishes may be observed waving above the water on shallow banks. Also the fish

probably blows holes in the sand in search of buried mollusca, which form an important part of its diet.

On occasions large fishes are hooked in water so shallow that the entire dorsal fin and part of the back may be exposed above the water. This species is not particularly timid, and it has been found possible to approach, with caution, to within 15 yards of specimens seeking food after the manner outlined above.

Lithognathus mormyrus Linn.

(Pls. XX and XXIX and text-fig. 19.)

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 706.

Depth 2·8–2·9, head 2·8–3 in body length. Eye 3–5·0 in head, 1·7–2·2 in snout, and 1·2–1·5 in preorbital depth. Snout fairly sharp, subconical.

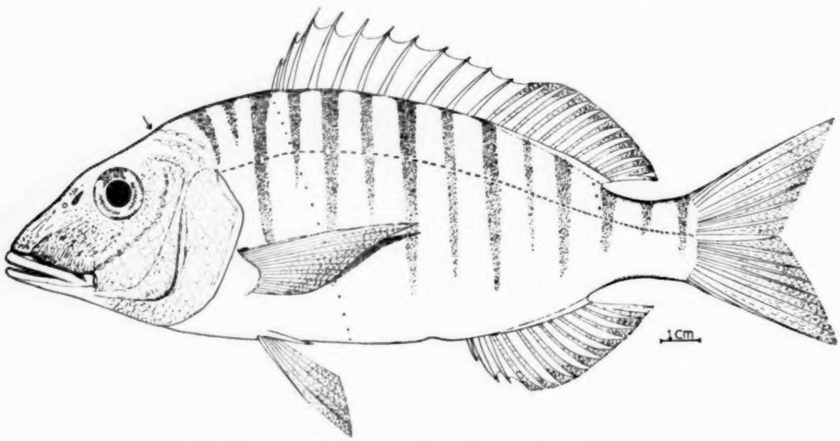

Fig. 19.—*Lithognathus mormyrus* Linn.
The rows of dots represent the number and disposition of scale rows. The small arrow shows the anterior margin of scaling on head.

Mouth very protractile, lips thin. Conical teeth small. Molars in 3–4 series above, 3 series in lower jaw. 14–15 gill-rakers. D XI, 12; A III, 10. Pectorals 1·3–1·4, ventrals 1·8–1·9 in head. Caudal deeply forked.

Scales with rounded hind margin, moderate, ctenoid (Pl. XXIX, figs. 3 and 6). Lateral line tubes short and wide, with two smaller tubules each opening by a pore behind (Pl. XX, fig. 6). l.l. 60–64, l.tr. $\frac{6}{13\text{–}14}$, 5–6 rows on cheek. Interorbital naked; scaling on head extends to above behind hind margin of eye. Preopercle flange naked.

Colour.—Silvery, dusky or greyish above, with about 14 narrow cross-bars, fading somewhat with preservation.

Length.—Up to 430 mm.

Locality.—Throughout the South African region entering estuaries. Extends to the Mediterranean; probably all round the coasts of Africa.

This is a well-known species, but never occurs in such numbers as to be of any commercial significance. It frequents sandy areas.

Subfamily SCATHARINAE.

Anterior teeth incisiform, in a single series, or in bands; outer teeth sometimes lanceolate, continued laterally, but no anterior group of a few enlarged teeth. Molariform teeth sometimes present. Dentition primarily sectorial. Mouth generally small, not or only slightly protractile. Premaxillary rami not or but little longer than pedicels.

Scales ctenoid. Interorbital naked, preopercle flange naked or scaly. Soft dorsal and anal either naked with low sheath, or scaly at base without sheath. Cheeks naked or scaly. Eye moderate; preorbital deep or shallow. 10–11 dorsal spines, usually not very long, moderately stout. Caudal moderately forked. Colour brownish, sometimes with longitudinal stripes.

Herbivorous fishes, of small or moderate size, usually found among rocks in shallowish water, some species common on banks in fairly deep water. Most species exclusively marine, not entering estuaries.

The species in this group are not of very great commercial or angling significance. One or two occur in relatively vast numbers, but are too small, or the flesh is too insipid, to render them of much importance. At some seasons the flesh of some is of rather rank flavour, which is probably due to the graminivorous habit.

No changes in nomenclature or arrangement are proposed in this group, chiefly owing to the recent revision of the main genera by Norman (*vide infra*).

Key to the Genera.

I. Cheeks naked . . . . *Gymnocrotaphus.*
II. Cheeks scaly.
- A. A single series of notched incisors only in each jaw . . *Sarpa.*
- B. Two or more series of teeth in each jaw.
  - X. Outer series of teeth movable, edges crenulate . . *Crenidens.*
  - Y. Outer series of teeth fixed, edges entire.
    - *a.* Some inner teeth lanceolate.
      - *x.* Soft dorsal and anal naked, with low sheath. Preorbital shallow, notched . . . *Spondyliosoma.*
      - *y.* Soft dorsal and anal scaly at base, without sheath. Preorbital deep, entire . . *Pachymetopon.*
    - *b.* All inner teeth obtuse, molariform . . . *Polyamblyodon.*

Genus *Gymnocrotaphus* Günther.

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 727.

Body ovate, moderately compressed. Eye small. Mouth small with an outer series of curved incisors in each jaw. Behind those one or two rows of subconical teeth and then a wide band of smaller teeth with rounded crowns, the inner series molariform. Posterior nostril slit-like. 10 dorsal spines. Soft dorsal and anal scaly basally, without sheath. Caudal emarginate. Prefrontals produced forward acutely.

Scales moderate, ctenoid. Lateral line tubes moderate, sometimes bifurcate. Cheeks naked; a small oval patch of scales behind eye. Interorbital and preopercle flange naked.

Genotype *curvidens* Günther, monotypic and endemic.

Gymnocrotaphus curvidens Gnthr.

(Text-fig. 20.)

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 727.

This well-known species can never be confused with any other and so does not need detailed redescription.

Body ovate, normally rather plump and soft. Depth 2–2·3 in body length. Eye 4–4·6 in head, 1·4–2 in preorbital depth. Mouth small,

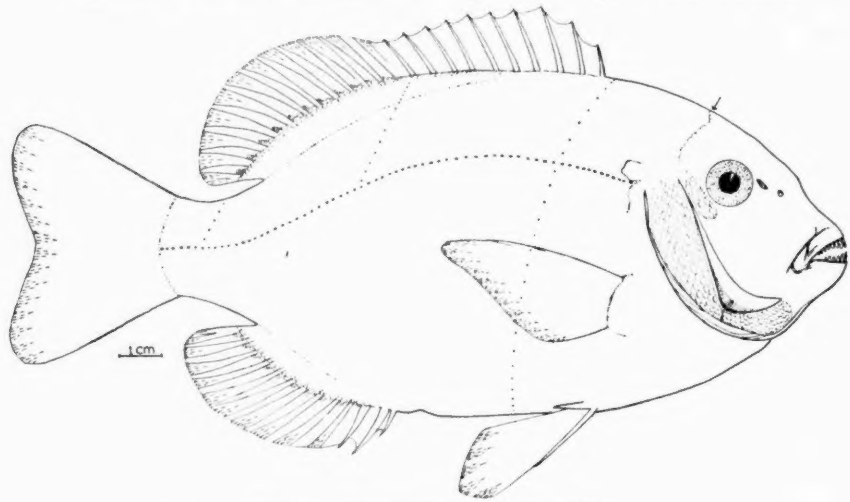

Fig. 20.—*Gymnocrotaphus curvidens* Gnthr.
The rows of dots represent the number and disposition of scale rows. The small arrow shows anterior margin of scaling on head.

scarcely protractile; outer series of enlarged curved incisors, almost exsert; a band of molariform teeth behind. 7–9 gill-rakers.

D X, 12: 3rd spine longest, 3–3·2 in head. A III, 10: soft dorsal and anal rounded. Pectoral 1·1–1·2, ventral 1·3–1·4 in head. Caudal emarginate, lobes broadly rounded.

Scales ctenoid. Lateral line tubes moderate, with oblique branch, or bifurcate and several pores behind. l.l. 64–68, l.tr. $\frac{7\text{–}8}{18\text{–}22}$. Cheeks naked, but a patch of scales in 3–4 series, an eye diameter deep, behind eye. Preopercle flange and interorbital naked. Scales on head extend to above hind third of eye. Soft dorsal and anal without sheath, densely scaly on basal third.

Colour.—Brown or bronzy, slightly lighter below. Iris blue.

Length.—Up to 350 mm.

Locality.—Cape Peninsula to Great Kei Mouth, in shallow water among rocks.

Contrary to usual statements, the inner teeth, while small, are distinctly molariform.

A species well known to the rock angler, but rarely, if ever, taken in any numbers. The flesh is usually delicate and tasty.

This is another rather highly localised species peculiar to South Africa.

Genus *Sarpa* Bonaparte.

1933. Fowler, U.S. Nat. Mus. Bull. 100, vol. xii, p. 181.

Body ovate, rather plump. Eye moderate. Mouth small with but a single series of incisors in each jaw, those in upper jaw notched, in lower jaw pointed, all with strong horizontal roots. No molars. 11 dorsal spines, slender. Soft dorsal and anal naked with very deep sheath. Caudal moderately forked.

Scales small, ctenoid. Cheeks scaly. Interorbital and preopercle flange naked. Air-bladder posteriorly bifurcated into two caudal horns. Peritoneum black.

It is rather doubtful whether this is really a Sparid genus. The overlapping of the maxilla by the premaxilla end is more nominal than real, while the horizontal roots of the teeth and the bifurcated hydrostatic organ are reminiscent of the Kyphosidae. The naked fins are, however, not characteristic of that family.

Temporarily the genus is included here since it has so long been accepted as Sparid, but its relationships will form the subject of later study.

A single species in South Africa.

Sarpa salpa Linnaeus.

1933. Fowler, *loc. cit.*, p. 181.

A well-known species, which does not need detailed redescription. Apparently extends almost right round Africa.

Depth 2·7–3. D XI, 14–15; A III, 13–14. l.l. 71–79, l.tr. $\frac{6}{14\text{–}16}$, 5–6 scales on cheek. 12–14 gill-rakers. Soft anal and dorsal naked, with very heavy scaly sheath.

Colour.—(Alive) Greenish or silvery bronze above, with a few faint light blotches along the back. Numerous narrow golden longitudinal stripes. Axil of pectoral black. Lateral line dark. The golden stripes fade on preservation.

Length.—Up to 450 mm.

This species occurs in large numbers along our coasts, and appears to attain the largest size in the cold waters of the western shores of the Cape Peninsula. Along the south coast it abounds in shallow water among rocks and reefs, and enters estuaries freely. It is regarded as an excellent bait-fish, but the flesh softens rapidly and, being rather strong flavoured, is not much esteemed as food.

Genus *Crenidens* Valenciennes.

1933. Fowler, U.S. Nat. Mus. Bull. 100, vol. xii, p. 201 (Girellidae).

Body ovate, moderately compressed. Eye moderate. Mouth small, in each jaw 2 series of incisors, edges quinquedentate, and behind those several rows of small molars.

11 dorsal spines. Soft dorsal and anal naked with moderate sheath. Caudal forked. Pectoral longer than head. Vertebrae 24 (10 + 14). Scales moderate, cycloid. Cheeks scaly; interorbital and preopercle flange naked. Air-bladder with slight caudal horns. Only the typical species in South Africa.

Fowler (*loc. cit.*, 1933) has placed *Crenidens* in the Girellidae, probably because of the crenulate incisiform teeth. Actually those teeth of *crenidens* are quinquedentate, whereas those of all the Girellidae are tricuspid. Further, in that family the vertebrae number 27 or 28, the pectorals are shorter than the head, there are 13–16 dorsal spines and no molariform teeth. *Crenidens* has 24 vertebrae, pectorals longer than head, 11 dorsal spines, while molariform teeth are present. Fowler, in the diagnosis of *Crenidens* (*loc. cit.*, p. 200), stated "no molar teeth," whereas on the next page he described the species *Crenidens crenidens* Forskäl as having "biserial molars."

Actually it has been found that *Crenidens* has the characteristic groove

in the premaxilla which bears on and overlaps the maxilla externally, so that it cannot be any but a Sparid genus.

Crenidens crenidens Forskäl.

(Pls. XXII and XXVI and text-fig. 21.)

This species does not require detailed redescription.

Body oblong ovate. Depth 2·4–2·5 in body. Eye 3·2–3·6 in head, about 1·5 times preorbital depth. 9–10 gill-rakers. Incisors apically brown, 12–14 in upper, 10–12 in lower jaw.

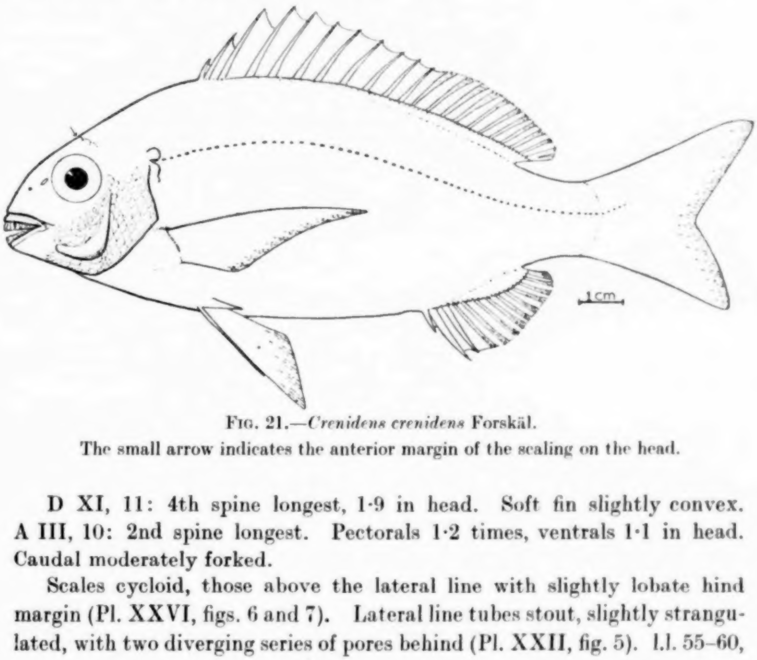

FIG. 21.—*Crenidens crenidens* Forskäl.
The small arrow indicates the anterior margin of the scaling on the head.

D XI, 11: 4th spine longest, 1·9 in head. Soft fin slightly convex. A III, 10: 2nd spine longest. Pectorals 1·2 times, ventrals 1·1 in head. Caudal moderately forked.

Scales cycloid, those above the lateral line with slightly lobate hind margin (Pl. XXVI, figs. 6 and 7). Lateral line tubes stout, slightly strangulated, with two diverging series of pores behind (Pl. XXII, fig. 5). l.l. 55–60, several more on caudal; l.tr. $\frac{5\text{–}6}{15\text{–}16}$, 3 cheek scales. Interorbital and preopercle flange naked. Scales on head extend to above centre of eye. Soft dorsal and anal naked, with low scaly sheaths.

Colour.—Silvery, greenish blue or olive above. Narrow longitudinal stripes show more clearly on preservation. Axil of pectoral sometimes darkish.

Length.—Up to 260 mm.

Locality.—East London northwards. Extends to the Indian region.

Easily distinguished from all other Sparid fishes by the crenulate incisors. Very young specimens may sometimes be confused with similar stadia of *Austrosparus auriventris* Peters, since the young of the latter have tricuspid incisors. In those cases the number of incisors is diagnostic.

The remaining South African Scatharine fishes, of the genera *Spondyliosoma* Cantor, *Pachymetopon* Günther, and *Polyamblyodon* Norman, have been described in great detail and figured by Norman (Ann. S.A. Mus., 1935, vol. xxxii, pt. 1, pp. 6–21), so that repetition is unnecessary. Keys for the species of those genera are copied from Norman's work.

Genus *Spondyliosoma* Cantor.

1935. Norman, Ann. S.A. Mus., vol. xxxii, p. 6.

Preorbital shallow, notched. Soft dorsal and anal naked, with low sheath. Narrow lanceolate incisors in 4–6 rows in each jaw, outer largest; an inner row obtuse, molariform. 11 dorsal spines. Scales ctenoid, with lobate hind margin.

Regional genotype *emarginatum* Cuv. and Val. Only one species in South Africa.

Spondyliosoma emarginatum C. & V.

(Pls. XXII and XXIX.)

1935. Norman, *loc. cit.*, p. 9, fig. 2.

Depth 2·2–2·6. Eye about equal to snout, 3–4 in head, 2–2·7 times depth of preorbital. Lower margin of preorbital notched. 15–17 gill-rakers.

D XI, 11–13; A III, 10; pectoral equal to head. Scales ctenoid, with lobate hind margin (Pl. XXIX, figs. 4 and 5). Lateral line tubes very wide, with a few large pores behind (Pl. XXII, fig. 2). l.l. 80–92, l.tr. 14–15 above. Preopercle flange and interorbital naked.

Colour.—Brownish; when alive, several very narrow, faint golden longitudinal stripes. Dorsal, anal, and ventrals darkish (in males only?). Extends from Saldanha Bay round the coast of South Africa to Natal and Madagascar.

Length.—Up to 300 mm.

According to Norman, *S. microlepis* G. & T. is a synonym.

Often found in tidal estuaries.

Genus *Pachymetopon* Günther.

1935. Norman, Ann. S.A. Mus., vol. xxxii, p. 11.

Preorbital moderately deep, lower margin not notched. Soft dorsal and anal scaly on basal third, but no sheath. Outer teeth broader and

fewer than in *Spondyliosoma*, no molariform teeth. 10–11 dorsal spines. Scales ctenoid. Five species in South Africa, one of doubtful validity (*q.v.*).

Key to the Species. (After Norman.)

I. 36–44 teeth in outer row of lower jaw. Preorbital depth less than eye. 13–16 gill-rakers.

- A. Preopercle flange naked. l.l. 60–66. Pectoral not longer than head.
  - X. 40–44 teeth in outer row of lower jaw. 1st dorsal spine $\frac{1}{2}$–$\frac{2}{3}$ eye . . . . *blochi.*
  - Y. 36 teeth in outer row of lower jaw. 1st dorsal spine $\frac{1}{3}$ eye . . . . *canescens.*
- B. Preopercle flange scaly. l.l. 80–86. Pectoral longer than head . . . . *aeneum.*

II. 22 teeth in outer row of upper jaw. Preorbital depth equal to eye. 10–11 gill-rakers.

- A. Depth 2·3 in length . . . . *grande.*
- B. Depth 1·8–2·0 in length . . . . *glaucum.*

Pachymetopon blochi Val.

(Pls. XXII, XXVIII, and XXIX.)

1935. Norman, *loc. cit.*, p. 12, fig. 3.

Depth 2·3–2·5 in length. Eye 3–5·2 in head, 0·9–1·5 times preorbital depth. End of maxilla exposed. 30–36 teeth in outer row of upper, 40–44 in outer row of lower jaw. 4–5 inner rows not as high. 13–14 gill-rakers. D X–XI, 11–12; A III, 10. Scales ctenoid, with semi-lobate hind margin (Pl. XXVIII, fig. 9; and Pl. XXIX, fig. 9). Lateral line tubes very wide and short with two lots of two pores behind (Pl. XXII, fig. 3). l.l.60–65, l.tr. $\frac{9\text{–}10}{18\text{–}20}$, 8–9 cheek scales. Scaling on head extends to above behind middle of eye. Preopercle flange and interorbital naked. Brownish; lighter below; sometimes bronzy.

Length.—Up to 450 mm.

Locality.—South-West African coast round the Cape, occasional specimens along the coast as far as Algoa Bay.

Pachymetopon canescens Norman.

1935. Norman, *loc. cit.*, p. 14, pl. ii.

Very closely related to *P. blochi*, and differs only in minor characters. Norman does not appear to have investigated the possibility of sexual dimorphism in this case; or at any rate he has made no statement about it.

(The following description compiled.) Depth 2·5 in body. Eye 4 in head, 1·4 times preorbital depth (the figure of *canescens*, *loc. cit.* above, shows eye 1·25 times preorbital depth). Preorbital almost concealing maxilla. 26–28 outer teeth in upper, 36 in lower jaw. D X–XI, 10–11: 1st spine about $\frac{1}{8}$ eye diameter. A III, 9–10. l.l. 65, l.tr. 10 above. 8–9 scales on cheek. Interorbital and preopercle flange naked. Scales on head as for *P. blochi.*

Yellow brown, patch below eye, one on operculum, darkish areas along upper half of side; lighter below. Longitudinal rows of dots along sides, some dots on fins.

Locality.—Kalk Bay.

Length.—Up to 275 mm.

Only two specimens are known, one of more or less unknown locality (holotype).

I have seen, at Lamberts Bay, "Hottentots" somewhat lighter in colour, with darker blotches, among the commoner brown specimens. They may have been *P. canescens.*

Pachymetopon aeneum Gilchrist and Thompson.

(Pls. XXII and XXIX.)

1935. Norman, Ann. S.A. Mus., vol. xxxii, p. 15, fig. 4.

Depth 2·3–2·6 in body. Eye 3·5–4·5 in head, 1·3–1·8 times depth of preorbital. A prominent bulge at interorbital, and the general effect of the snout is simocephalous. 15 gill-rakers. 30–36 outer teeth in upper, 36–40 in lower jaw. D XI, 11; A III, 10. Pectoral 1·2 times head. l.l. 80–86, l.tr. $\frac{10\text{–}11}{21\text{–}23}$, 10 cheek scales. Interorbital with scaling on upper portion. Preopercle flange scaly. Scales almost cycloid, ctenae on ventral scales only very feeble (Pl. XXIX, figs. 7 and 8). Lateral line tubes narrow and long, with one or two pores behind (Pl. XXII, fig. 4).

Colour bronzy or brown, preserved specimens sometimes show longitudinal streaks.

Length.—Up to 510 mm.

Locality.—False Bay to Natal.

The combination of small cycloid or weakly ctenoid scales, the scaly preopercle flange, and several other features distinguish this from the other species of *Pachymetopon*, so as almost to merit separation by full generic rank.

This is a well-known angling fish, being taken not only from the shore among rocks but also from boats on banks down to 30 fathoms. The flesh is firm and of good flavour and highly esteemed. Specimens of

10–12 lbs. in weight are not uncommon. The species bites freely and fights well when hooked, and so is esteemed by anglers.

At nights large specimens may occasionally be found in numbers in quite shallow water among rocks, and they are often secured by spearing.

Pachymetopon grande Günther.

1935. Norman, *loc. cit.*, p. 17, fig. 5.

(Compiled description.)

Slight interorbital prominence. Depth 2·3 in body. Eye 4 in head, equal to preorbital depth. Maxilla not concealed. 18–20 teeth in outer row of upper jaw, 22 in lower. 10–11 gill-rakers. D XI, 11; A III, 10–11. Pectoral 1·4 times head. l.l. 80, l.tr. 11 above, 7 cheek scales. Preopercle flange naked. Interorbital naked, scales on head extend above front third of eye.

Brownish, with narrow lines along lower half of side. Fins mostly dark.

Length.—Up to 520 mm.

Locality.—South-Eastern Cape to Madagascar.

Not plentiful in South African waters.

Pachymetopon glaucum Norman.

1935. Norman, *loc. cit.*, p. 20, fig. 6.

This species is very close indeed to *P. grande*, and has been founded on a single specimen. Both forms are evidently rather rare, and again in this case sexual dimorphism may account for the variations. Certainly the differences are not very great.

(Description compiled.)

Depth 1·8 in body (the figure shows depth 2 in body; Norman, *loc. cit.* above). Eye 3·7 in head, about equal to preorbital depth. Maxilla not concealed. 11 gill-rakers. 22 teeth in outer row in each jaw. D XI, 11; A III, 11. Pectoral 1·33 times head. l.l. 85, l.tr. above 10–11, 7 cheek scales. Preopercle flange naked. Interorbital naked, scaling on head to above front third of eye. Dark grey above, lighter below. Narrow lines along lower half of side. Fins dark.

Length.—310 mm.

Locality.—East London.

A very doubtful species indeed, the sole differences stated being that *glaucum* has a deeper body and a shorter pectoral than *grande*. A specimen recently obtained from East London renders the validity of *glaucum* still more doubtful. This specimen, an adult male, 470 mm. total length, has depth 2·18, head 4·0 in body. Eye 4·8 in head, 1·3 in preorbital depth.

26 upper and 24 lower teeth. 10 gill-rakers. D XI, 11; A III, 10. Pectoral 1·33 times head, ventrals 1·25 in head. Lateral line scales 80. Interorbital naked.

This agrees in the main with the diagnosis of *grande*, and leaves *glaucum* to rest solely on the greater depth of the body, a feature of doubtful validity, for in these fishes it might be due to distension produced by intestinal decomposition which occurs soon after death unless preservatives are employed.

Genus *Polyamblyodon* Norman.

1935. Norman, Ann. S.A. Mus., vol. xxxii, p. 21.

Very closely allied with the preceding genus, but differs chiefly in the dentition: the teeth of the inner rows small and rounded, molariform; the outer teeth strong, curved, compressed.

It is of interest to note that Norman evidently regards the dentition in the Sparidae of such great significance as to found a genus upon that character alone.

Polyamblyodon germanum Barnard.

1934. Barnard, Ann. Mag. Nat. Hist. (10), vol. xiii, p. 230, fig. 2 (head and teeth).

1935. Norman, *loc. cit.*, p. 21.

Interorbital prominent, gibbous. Depth 2·5 in body. Eye 4–4·3 in head, 1·2 in preorbital depth. 16 gill-rakers. D XI, 11; A III, 11. l.l. 71, l.tr. $\frac{9}{29}$, 8 cheek scales. Preopercle flange and interorbital naked, scales on head extending to above hind nostril. In outer rows in upper jaw 40 teeth, 52 in lower. 7 rows of small molariform teeth.

Only two specimens known, 368 and 375 mm. length, from Durban.

Evidently a very rare species.

Family DENTICIDAE.

Body compressed, elongate or elongate-oval. Mouth moderate to large, usually fairly protractile. Maxilla usually partly exposed. Teeth all acute, anteriorly always a small group of separated, large, curved, fang-like teeth, truly caniniform. Laterally one or more rows of acute teeth, no molariform teeth. No palatal or lingual teeth. Outer teeth implanted in sockets, replacement by vertical succession.

Gills 4, a slit behind the 4th. Gill-rakers usually lanceolate, sometimes short and blade-like (*Petrus*), in moderate number. Gill-membranes free from isthmus. Pseudobranchiae present. Air-bladder usually simple. Pyloric caeca few.

Dorsal single, seldom deeply notched. 3 anal spines, 2nd and 3rd usually subequal. Ventrals of a spine and 5 rays, with axillary scale. Caudal forked.

Scales usually ctenoid; sometimes cycloid scales also present (*Gymnocranius*). Soft dorsal and anal usually naked with low or moderate sheath, sometimes basally scaly without sheath (*Petrus*).

Skull with well-developed occipital and parietal crests. Premaxillary pedicels usually short, much shorter than the relatively slender rami (see fig. 2). The premaxilla in its distal extremity has some form of groove in the upper margin, in which rests part of the lower edge of the maxilla, as described for the Sparidae. Dentaries moderate. A strong subocular shelf from the 2nd suborbital. Vertebrae 24 (10 + 14). Parapophyses from the 3rd precaudal, and the 1st rib sessile.

The type genus occurs in the Atlantic and has been held to extend also into the Indo-Pacific. That view is not held here, a decision which is in keeping with the finding in the related Sparidae, namely, that the Atlantic and the Indo-Pacific forms in the family are generically distinct. The seven South African species in this family were placed in the single genus *Dentex* Cuv. by Barnard (Ann. S.A. Mus., 1927, vol. xxi, pp. 711 ff.), who gave *Gymnocranius* Klunz. only subgeneric rank. Fowler (1933, U.S. Nat. Mus., vol. xii, pp. 116 ff.) placed most of our species in *Dentex* Cuv., but accepted *Gymnocranius* Klunz. as valid, with one species in South Africa.

Examination has shown that there is every justification for regarding all the South African species as distinct generically from *Dentex* Cuv. In that genus the scales on the head do not, or scarcely, reach the interorbital region, while the dorsal and anal are quite naked with a very low sheath. The South African species all have the interorbital scaly, the scales usually covering the whole extent of that region to well in advance of the eye, while the soft dorsal and anal are either basally scaly without sheath, or else have very heavy sheaths. Jordan and Thompson (Proc. U.S. Nat. Mus., 1912, vol. xli, pp. 570 ff.) had actually observed the significance of the divergence of the Indo-Pacific form from that of the typical genus, and had proposed at that time the genus *Taius* for the former species. Actually, as will be seen, *Polysteganus* Klunz. must have priority, and *Taius* becomes a synonym.

Fowler's treatment of the group of the species of *Dentex* Cuv. is characterised by most lamentable carelessness or inaccuracy. His diagnosis of the genus (*loc. cit.*, 1933, p. 117) alone contains numerous characters which are most emphatically not applicable to all our species, while he has included in the list of species some which cannot possibly belong there (*cf.* p. 125, *Dentex peronii* Val. and *Dentex matsubarae* J. & E.). In his key to the

species (*loc. cit.*, p. 118), subgenus *Dentex* has "Frontal scales not extending forward before eye," whereas the descriptions of the species in that group in most cases have "Predorsal scales forward to nostrils," which examination of the specimens would show to be the case.

The seven South African species have been divided into four genera, the proposed arrangement being as follows:—

Genus.	*Species.*
Gymnocranius Klunzinger	*robinsoni* G. & T.
Petrus n.g.*	*rupestris* Valenciennes * (type).
Polysteganus Klunzinger	*coeruleopunctatus* Klunz.
	undulosus Regan.*
	argyrozona Valenciennes.*
	praeorbitalis Günther.*
Cheimerius n.g.	*nufar* Valenciennes (type).

Genera and species marked * are endemic.

The South African species in this family are all mostly carnivorous and live in fairly deep water. Only one comes regularly close inshore or enters estuaries. Some occur in large numbers and are of considerable economic significance in South Africa. Most are some shade of red or pink, sometimes with cross-bars or stripes. Only one species attains a large size, mostly fishes of moderate size.

Key to the Genera of the Denticidae.

I. Interorbital and preopercle flange quite naked. 10 dorsal spines . *Gymnocranius.*

II. Interorbital and preopercle flange at least partly scaly. 11–12 dorsal spines.

- A. 1st and 2nd dorsal spines very short, abruptly shorter than 3rd. 3rd and some following spines elongate, filamentous . . . . *Cheimerius.*
- B. Dorsal spines graduated, first 2 not abruptly shorter and none filamentous.
  - X. Scales on head do not extend above front margin of eye, nor right across interorbital. Soft dorsal and anal naked, with very low sheath (Atlantic only) . (*Dentex.*)
  - Y. Scales on head extend beyond above front margin of eye and completely cover interorbital. Soft dorsal and anal scaly at base or with marked sheath. (Indian and Indo-Pacific.)
    - *a.* 12 dorsal spines. Gill-rakers lanceolate. Soft dorsal and anal naked with sheath . . *Polysteganus.*
    - *b.* 11 dorsal spines. Gill-rakers short and compressed. Soft dorsal and anal scaly without sheath . . . . *Petrus.*

Genus *Gymnocranius* Klunzinger.

1870. Klunzinger, Synop. Fisch. d. Roth. Meer., p. 764.
1933. Fowler, U.S. Nat. Mus. Bull. 100, vol. xii, p. 129.

Body compressed, deep. Eye rather large, preorbital deep. Mouth moderate. Conical teeth in several series in jaws; anteriorly 4–6 enlarged, caniniform. Gill-rakers few. 10 dorsal spines, moderate. Soft dorsal and anal naked, with basal sheath. Caudal forked. Posterior nostril rounded, subequal to anterior. Scales almost cycloid, at most very feebly denticulate, rather large, about 50 series. Preopercle flange and interorbital naked. Air-bladder bifurcate, with short caudal horns.

This genus has not generally been accepted as valid in regard to the South African fauna. Actually, even a superficial examination of *G. robinsoni* shows immediately that it must receive distinction by full generic rank from all other Denticid fishes in South Africa. The naked interorbital and preopercle flange, the large eye, the shape of the head and body, the dentition, and the almost cycloid scales are more than sufficient to establish the validity of *Gymnocranius*.

Only one species, *G. robinsoni* G. & T., in South Africa. It is of no commercial significance there.

Gymnocranius robinsoni Gilchrist and Thompson.

(Pls. XXI and XXVII.)

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 712.

Depth 2·3–2·7, head 3·0–3·1 in length of body. Eye 2·8–3·4 in head, about equal to preorbital depth. Posterior nostril small, circular. Mouth moderate, maxilla exposed. Canines rather small, irregular; inner villiform teeth in bands.

D X, 10–11; A III, 9–10. Caudal forked.

Scales above lateral line cycloid, those below on hinder part of body with faint signs of granulations (Pl. XXVII, figs. 1 and 2). Lateral line tubes moderate, rather oblique, no pores behind (Pl. XXI, fig. 2). l.l. 46–50, l.tr. $\frac{6\text{–}7}{18\text{–}19}$, 4 or 5 series on cheek. Whole of interorbital and preopercle flange scaleless. Soft dorsal and anal scaleless, with sheath. Stated to be silvery. Specimens when preserved would appear to have been pink or red in life, stated also to have wavy blue lines across snout, cheek, and opercle; dorsal and anal rosy yellow, caudal and pectoral pinkish. These colours fade on preservation.

Length.—Up to 400 mm.

Locality.—Natal.

Extends up the east coast of Africa to the Red Sea.

This species appears to be very rare in our waters; even in Natal few specimens are taken.

May easily be distinguished from all other South African Denticid fishes by the naked cranium and preopercle flange, only 10 dorsal spines and the relatively large eye, besides other features.

Certainly does not fall with the Atlantic *Dentex* Cuv.

Genus *Cheimerius* n.g.

Body fairly compressed. Snout moderately sharp. Eye moderate; preorbital about equal to eye. Posterior nostril oval. Mouth moderate. Villiform teeth in narrow bands in each jaw, become more obtuse posteriorly, the inner hinder series having rounded crowns, verging on the molariform. Anteriorly in each jaw 4 strong caniniform teeth, occasionally also 2 smaller median. Gill-rakers lanceolate.

12 dorsal spines, the first 2 short, 3rd abruptly longer, filamentous; also the 4th–6th filamentous but shorter than the 3rd. 1st ventral ray prolonged. Colour red, with faint cross-bars.

Scales ctenoid, moderate. Preopercle flange mostly naked. Interorbital only partly scaly, scaling not right across and coming to a point anteriorly. Soft dorsal and anal naked with low sheath. Lateral line tubes more or less bifurcate (Pl. IV, fig. 3).

Type *C. nufar* Valenciennes, monotypic.

This genus has the same standing in the Denticidae as has *Argyrops* Swainson in the Sparidae. Not only is *Cheimerius* distinguished from other Denticid genera by numerous taxonomic characters, but its habits (*q.v.*) also set it apart.

The single species ranges from the Cape along the coast of Africa to the Indo-Chinese region.

Cheimerius nufar Valenciennes.

(Pls. XXI and XXVII and text-fig. 22.)

Dentex miles Gilchrist and Thompson, Ann. S.A. Mus., 1908, vol. vi, p. 155; Fowler, Proc. Ac. Nat. Sci. Phil., 1925, vol. lxxvii, p. 240.

Dentex albus Gilchrist and Thompson, Mar. Biol. Rep. S.A., 1914, No. 2, p. 128, fig.

Dentex filosus (non Valenciennes) Gilchrist, Ann. Durb. Mus., 1917, vol. i, pt. 4, p. 356; Barnard, Ann. S.A. Mus., 1927, vol. xxi, p. 715; Fowler, U.S. Nat. Mus. Bull. 100, 1933, vol. xii, p. 126.

Dentex nufar Day, Fishes of India, 1878–1888, pl. xxxiv, fig. 4 (not in text, no description).

Dentex variabilis Valenciennes, Hist. Nat. Poiss., 1830, vol. vi, p. 241 (Red Sea).

Polysteganus nufar (Ehrenberg), Klunzinger, Synopsis d. Fische d. Rot. Meer., 1870, p. 764.

Dentex nufar Valenciennes, Hist. Nat. Poiss., 1830, p. 240; Ruppell, Neue Wirbel., 1835, p. 115; Fowler, Hong-Kong Nat. Hist., 1931, p. 171; Fowler, U.S. Nat. Mus. Bull. 100, 1933, vol. xii, p. 127.

Dentex rupestris (non Val.) Fowler, 1925, *loc. cit.*, p. 239.

Body ovate, moderately deep and compressed. Dorsal profile of snout even and fairly low. Snout moderately sharp, subconical. Depth 2·3–2·6,

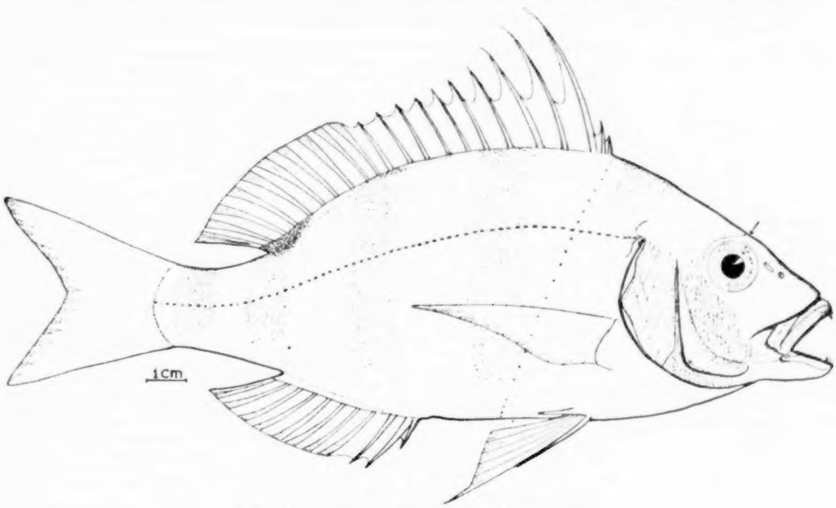

FIG. 22.—*Cheimerius nufar* Valenciennes.

The rows of dots represent number and disposition of scale rows. The small arrow shows anterior limit of scaling on head.

length of head 3–3·4 in length of body. Eye 3(juv.)–4·6, snout 2·3–2·6, interorbital 3·2–3·5, and postorbital 2·4–2·5 in length of head. Preorbital depth slightly less than (juv.) to slightly greater than (ad.) eye diameter. Posterior nostril oval. Preopercle margin serrate round angle and lower margin in juveniles. Lower margin of preorbital straight in juveniles, gently convex ventrally in half-grown and adult stadia. Mouth moderate, maxilla extends to below anterior part of eye. Premaxillary pedicels longer than in *Polysteganus* Klunz. but not as long as rami. 4–6 fairly strong canines in the front of each jaw, the inner pair always small, often absent, except in juveniles. In each jaw a narrow band of small villiform

teeth, outer lateral series enlarged, inner posterior series rather obtuse. Maxilla largely concealed, but end exposed. Jaws about equal. Gill-rakers 13–14, lanceolate, 2 in gill filaments, which are 2 in eye.

D XII, 10 (one species out of thirty examined had D XI, 11): inserted behind hind opercular margin. 1st spine 3·5–4; 2nd 2 in eye; 3rd abruptly longer, filamentous, length varies with age. In juveniles it is shorter than in half-grown specimens, in which it is longest, slightly longer than head to 1·4 in head. In large adults the 3rd spine appears to be relatively shorter, but that is probably due to damage. The 3rd–7th spines are generally filamentous, the 3rd always longest; 3rd spine 0·9–1·4, 4th 1·4–1·6, 5th 1·7–1·9, 6th 2·0–2·1, 12th 3·2–3·3 in head. Soft rays slightly higher than last spine, about 2·9–3 in head. Base of soft fin 1·6–1·7 in base of spinous. Edge of soft fin gently convex, last ray not shortened, slightly longer than penultimate.

A III, 8: inserted below the 10th dorsal spine. 1st spine 1·2 in eye, 2nd and 3rd subequal, 1·4 times eye. Edge of soft fin gently convex.

Pectoral 1·0–1·2 (juv.) in head, tip reaches above anal origin, ventrals with 1st ray filamentous, reach to anal origin, 1·3–1·4 in head. Caudal forked.

Scales moderate, ctenoid (Pl. XXVII, figs. 3 and 8). Lateral line tubes moderate; posteriorly 2 tubules, each opening externally by a pore (Pl. XXI, fig. 3). l.l. 59–63, l.tr. $\frac{8}{16}$, 8–9 cheek scales. Preopercle flange mostly naked, usually a few series of scales round inner lower margin. Interorbital partly scaly, scaling does not extend right across the interorbital, and comes to a point above or behind the front margin of the eye. Soft dorsal and anal naked, with low sheath.

Colour.—(Just after death) Rosy, lighter below, with 5 rather faint, broad, darker red cross-bars. Anal margin, ventrals, and lower caudal lobe blue. A bronze bar vertically through iris over pupil. Hind margin of caudal dusky. A red-brown blotch at the base of the hind dorsal rays. (Preserved) More or less uniform reddish brown (cross-bars fade rapidly).

Length.—Up to 600 mm.

Locality.—From the Cape Peninsula to Natal, entering estuaries occasionally when young. Extends to the Red Sea, India, and China. Will probably be found through the whole Indo-Pacific.

There has been considerable confusion over this somewhat variable species, which in South Africa has hitherto been regarded as identical with the Atlantic species *filosus* Valenciennes. The latter apparently has the 2nd dorsal spine filamentous, D XI, 11, and longitudinal red bands, but otherwise does not differ very widely from *nufar*. *filosus* does not

apparently extend farther south than Angola and certainly does not occur in South Africa.

Day's lapse in providing a figure of *D. nufar* without reference in the text is rather curious (*vide supra*, Day). His figure leaves no doubt as to the identity of the specimen.

There appears to be little doubt that *miles* G. & T. and *albus* G. & T. are synonyms. The type specimens have been examined and compared with others, and while variations in the lengths of the first 3 dorsal spines occur, they hardly justify the maintenance of a species distinct from *nufar*. *nufar* is rather variable in body shape and in the lengths of the dorsal spines.

The genus has been named from a characteristic of the type, at least in South Africa. *nufar* appears in our tidal rivers just before bad weather at sea. At Knysna, should that species be taken in the nets, one may be certain of a storm at sea within twenty-four hours. Individuals remain in the river during the stormy weather and occasionally for a few days after, but I have never heard of a specimen being taken in the river during a long fine spell.

This species generally appears to be of solitary habit.

Genus *Polysteganus* Klunzinger.

1890. Klunzinger, Synopsis d. Fische d. Roth. Meer., p. 763.
1912. Jordan and Thompson, Proc. U.S. Nat. Mus., vol. xli, p. 570 (*Taius*).

Body fairly compressed, snout blunt or conical. Eye moderate. Preorbital depth less than or greater than eye. Posterior nostril usually oval. Mouth moderate. Anterior canines either moderate and subequal or with outer much-enlarged and inner smaller pair. Lateral teeth either slight and fang-like or rather heavy but acute. A few small villiform teeth behind the canines in each jaw. Gill-rakers lanceolate, fairly numerous.

12 dorsal spines, graduated, no abrupt differentiation, none filamentous.

Scales ctenoid, moderate, hind margin sometimes lobate. Preopercle flange completely scaly. Interorbital scaly right across, scaling to above in advance of eye margin, front edge of scaling rounded. Soft dorsal and anal naked, with marked sheath. Lateral line tubes with 2 smaller tubes behind or diverging series of pores giving appearance of bifurcate tubes.

Genotype *coeruleopunctatus* Klunzinger.

Colour usually reddish, generally with some blue longitudinal markings.

Of all our Denticid fishes these might perhaps be held as closest to the Atlantic *Dentex* Cuv. As previously indicated, however, there are numerous differences which justify maintaining the Indo-Pacific forms as separate by full generic rank.

The four South African species of this genus fall into three distinct subgroups, here accorded subgeneric rank, an admitted compromise. An examination of material from the whole Indo-Pacific may ultimately establish them as full genera.

These fishes are generally found in moderately to fairly deep water and are all of economic significance.

Key to the Species.

I. Preorbital depth usually less than eye, only occasionally greater in largest adults. Scales above lateral line more than half the depth of those below. Eye rather large.

A. (*Polysteganus*).

Head length less than body depth. Hind margin of maxilla partly concealed beneath preorbital. Body ovate, not very elongate. Jaws about equal. Canines weak, upper 4 subequal. 13–16 gill-rakers. Posterior nostril oval. Pectoral as long as or longer than head.

X. Rows of dots on each scale row on upper part of body. Pectoral longer than head . . *coeruleopunctatus.*

Y. 4–6 wavy longitudinal stripes and a blotch below the 6th dorsal spine. Pectoral equal to head *undulosus.*

B. (*Argyrozona*).

Head length equal to body depth. Hind margin of maxilla completely exposed. Body elongate. Lower jaw projects strongly. Canines not equal, in each jaw outer pair very strong, inner feeble. 18–20 gill-rakers. Posterior nostril circular. Pectoral much shorter than head . . . . *argyrozona.*

II. (*Axineceps*).

Preorbital always much deeper than eye. Scales above lateral line less than half depth of those below. Eye rather small *praeorbitalis.*

Subgenus *Polysteganus* Klunzinger.

Polysteganus coeruleopunctatus Klunzinger.

(Pls. XXII and XXVII.)

Polysteganus coeruleopunctatus Klunzinger, Synopsis Fische d. Roth. Meer., 1870, p. 763; Fowler, U.S. Nat. Mus. Bull. 100, 1933, vol. xii, p. 128 (Red Sea).

Dentex lineopunctatus Boulenger, Ann. S.A. Mus., 1903, vol. iii, pt. 2, p. 66, pl. vi; Barnard, Ann. S.A. Mus., 1927, vol. xxi, p. 718 (Natal); Fowler, 1933, *loc. cit.* above, p. 121.

Dentex natalensis Gilchrist and Thompson, Ann. S.A. Mus., 1908–11, vol. vi, p. 156 (Natal); and Fowler, Proc. Ac. Nat. Sci. Phil., 1925, vol. lxxvii, p. 240 (Delagoa Bay).

Dorsal profile of snout evenly convex, not very steep. Depth 2·3–2·5, length of head 3·1–3·5 in length of body. Eye 3–4·1, snout 2·3–3·0, interorbital 3–3·2, and postorbital part of head 2·3–2·4 in length of head. Preorbital depth 1·3–1·6 in eye, lower margin of preorbital gently convex, not concealing maxilla. Posterior nostril oval. Preopercle margin round angle and lower margin feebly serrate in smaller specimens. Mouth rather small, maxilla extends below anterior margin of eye, jaws equal. Canines moderate, 4 in upper, 6 in lower jaw, subequal. Outer lateral teeth broadly conical, hinder rather obtuse. A few series of weak villiform teeth behind the canines. Gill-rakers lanceolate, 12–13 on lower limb of anterior arch.

D XII, 10: inserted behind hind margin of opercle. 1st spine 4, 2nd 2·5, 3rd 2·1, 4th and 5th 1·6, 6th 2·0, last 2·8 in length of head. Soft rays slightly higher than last spine, edge of fin gently convex. Base of soft fin 2·2 in base of spinous.

A III, 8: inserted below the base of the 1st dorsal ray. 1st spine 1·2 in eye, 2nd and 3rd subequal, 1·2 times eye. Soft rays higher than spines, edge gently convex.

Pectoral 1·2 times head, tip reaches above base of 3rd anal spine. Ventrals 1·3 in head, reach to vent. Caudal deeply forked, lobes long.

Scales ctenoid, moderate, those above the lateral line more than half width of those below (Pl. XXVIII, figs. 7 and 8). Lateral line tubes short, moderate, 2 small tubes posteriorly, each ending in a pore, and each with another pore behind (Pl. XXII, fig. 6). l.l. 52–56, l.tr. $\frac{7}{17}$ (advance of dorsal origin back), 5–6 above lateral line below anterior dorsal spines. 7–8 series on cheek. Flange of preopercle scaly, but broad naked outer margin. Interorbital scaly, scales extend to above anterior nostril. Soft dorsal and anal naked, with moderate sheath.

Colour.—Reddish, with blue grey shade above. All scale rows above lateral line show as series of blue spots, one on each scale, forming curved rows above shoulder, more or less straight posteriorly and below the lateral line. Ventrals dark violet. Iris bronzy.

Length.—Up to 400 mm.

Locality.—Natal to Delagoa Bay. Extends to the Red Sea.

It is perhaps venturesome to unite two species without having compared the original types, but in this case there is little doubt that *lineopunctatus* Boulenger is a synonym of *coeruleopunctatus* Klunzinger. The few differences between specimens of the former and the description of the latter are not of great significance. *coeruleopunctatus* was stated to have l.l. 50, l.tr. $\frac{5\text{–}6}{16}$, and eye greater than interorbital. *lineopunctatus* has l.l. 52–56,

l.tr. $\frac{7}{17}$, and an eye about equal to the interorbital. Otherwise the description of the former fits the latter exactly. In specimens of *lineopunctatus* there are 7 scales above the lateral line to the origin of the dorsal, but only 5–6 between the lateral line and the anterior part of the spinous dorsal.

P. coeruleopunctatus is somewhat variable in body shape and in the arrangement of the rows of dots. It may be indicated that Boulenger's figure (*loc. cit.*, pl. vi, above) of the type of *lineopunctatus* agrees in hardly any important particular with the description. The text gives eye in head 3, eye in snout 1·0, head in body 3·0, depth in body 2·3, whereas the figure shows eye in head 3·6, eye in snout 1·6, head in body 2·7, and depth in body 2·6. There are other inaccuracies also. *P. natalensis* G. & T. is certainly synonymous and was founded probably because of the inaccuracies in the original description of *lineopunctatus* indicated above.

coeruleopunctatus probably occurs along the coast of Africa from Natal to the Red Sea. It appears to some extent to be migratory; at any rate it is more plentiful in Natal during the winter months, when it is of reasonable economic significance.

Polysteganus undulosus Regan.

(Pls. XXI and XXVIII and text-fig. 23.)

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 719, fig. (outline of head of adult).

1935. Fowler, Proc. Ac. Nat. Sci. Phil., vol. lxxxvii, p. 390 (*Dentex filosus*).

Dorsal profile evenly convex in juveniles: adults develop nuchal gibbosity; believed to be in males only.

Depth 2·5–2·9, length of head 3·2–3·6 in length of body. Eye 3·1 (juv.)–5·5, snout 3·1–3·5 in length of head. Eye 2·2–1 times depth of preorbital, only in very large adults is the preorbital depth equal to or even slightly more than eye. Posterior nostril oval. Preopercle margin weakly serrate round angle in juveniles. Mouth small, maxilla extends below anterior border of orbit, or not quite so far. Lower margin of preorbital somewhat undulate, conceals upper portion of hind end of maxilla. Jaws about equal. 4 upper canines subequal, rather feeble. 6 lower canines weak, median pair small. Lateral teeth curved, fang-like, more slender than those of *coeruleopunctatus*. A small band of villiform teeth behind canines in each jaw. 14–16 gill-rakers, short, 3·5 in gill-filaments, which are 2 in eye.

D XII, 10: originates behind opercular margin. Spines moderate, 4th and 5th subequal, longest, 2–2·2 in head. Soft rays slightly longer than last spine, edge of fin gently rounded.

A III, 8–9: inserted below the base of the 1st anal ray. Edge of soft fin gently rounded. Pectoral equal to head, just reaches above anal origin. Ventrals 1·4–1·5 in head, do not reach vent. Caudal well forked.

Scales ctenoid, mostly with more or less lobate hind margin (Pl. XXVIII, figs. 1 and 2). Lateral line tubes fairly stout, with 2 posterior tubules and indistinct pores (Pl. XXI, fig. 5). l.l. 58–62, l.tr. $\frac{9\text{–}10}{19\text{–}20}$, 9–11 scales on cheek. Preopercle flange scaly with very narrow naked margin, scales

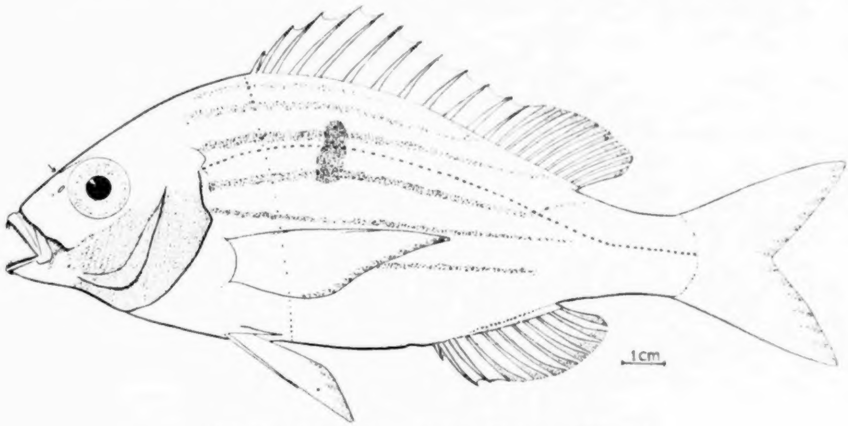

FIG. 23.—*Polysteganus undulosus* Regan. (Juvenile.)
The rows of dots shows number of scale rows. The small arrow indicates anterior margin of scaling on head.

sometimes partly lost with age. Interorbital scaly, scaling on head extends above anterior nostril. Soft dorsal and anal naked with low sheath.

Colour.—Reddish, to white below; bronzy-blue iridescence along back. 4–6 wavy, longitudinal, narrow, blue streaks along upper part of side, and a vertically elongate blue-black blotch across the lateral line below the base of the 5th–6th dorsal spine. Fins variously bluish, pink, or violet. Colours just after death are exceedingly beautiful. Preserved specimens fade to a brown-grey, and the lines and the blotch show blue-black.

Length.—Up to 1000 mm.

Locality.—Table Bay to Natal, most plentiful on the Agulhas Bank.

A well-known and highly esteemed angling and table fish. Usually frequents rather deep water, but occasionally shoals come inshore and numbers are taken by rock anglers from the deeper water.

Argyrozona new subgenus.

As defined in the key to the species of *Polysteganus* Klunz. Also, the hind upper margin of the maxilla is pointed and not covered by the preorbital.

Polysteganus argyrozona Valenciennes.

(Pls. XXI and XXVII and text-fig. 2.)

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 717 (*Dentex argyrozona*).

This species is so well known and so easily recognised by the protruding lower jaw, the acute end of the exposed maxilla, the widely spaced canines, the inner pair small, the outer very large, and the relatively low long head with flat profile of snout, as not to need detailed redescription.

Depth 2·9–3·2, equals head length. Eye 3·6–4·8 in head, 1·2 in interorbital, and 1·2–1·5 in snout, 1·6–2·0 times depth of preorbital. Snout pointed, subconical, dorsal profile low, almost straight. Posterior nostril larger than anterior, almost circular. Mouth fairly large, maxilla extends below anterior fourth of eye. Whole of distal end of maxilla exposed, upper hinder angle rather acute. Teeth markedly variable in size. Outer canines rather large, inner pair small, all widely spaced. Lateral teeth fang-like, slender, variable. An inner slight band of villiform teeth (fig. 1). 18–20 gill-rakers, slender, 1·4 in gill filaments, which are 2·1 in eye.

D XII, 10: inserted behind hind end of opercle. Spines slender, 4th and 5th longest, subequal, 2·7–2·8 in head. Edge of soft fin gently rounded. A III, 8: inserted below the base of the 1st dorsal ray. Pectorals 1·3–1·4 in head, do not reach near anal origin. Ventrals 2·1–2·2 in head, tip reaches half-way to anal origin. Caudal forked.

Scales moderate, ctenoid, hind margin markedly lobate (Pl. XXVII, figs. 6 and 7). Lateral line tubes short and stout, with 2 large pores behind (Pl. XXI, fig. 4). l.l. 59–62, l.tr. $\frac{7\text{–}8}{18\text{–}19}$, 7–8 cheek scales. Preopercle flange mostly scaly, fairly broad naked margin. Interorbital scaly, scales extend to before above anterior nostril. Soft dorsal and anal naked, with low sheath.

Colour.—Silvery rose-red, lighter below. Just after death several bright longitudinal bands show. Fins pink or rosy.

Length.—Up to 800 mm.

Locality.—Table Bay to Natal, down to 90 fathoms.

Almost certainly *argyrozona* will eventually receive distinction by full generic rank from all other South African fishes. The long low head, the strong canines, the circular hind nostril, the peculiar scales, and the

fully exposed maxilla end, of which the upper angle is characteristic in being acutely produced, are all distinctive.

Economically an important fish; usually taken in large numbers by line boats, chiefly during the winter months. In False Bay large numbers of the juvenile and half-grown fishes, known as "Doppies," are taken on lines from boats, sometimes from the rocks in deepish waters. Professional fishermen of False Bay have long maintained that the "Doppie" and the "Silver-fish" are different species, but an examination of a series reveals no differences to justify their view.

Axineceps new subgenus.

As defined in the key to the species of ***Polysteganus*** Klunz. Easily distinguished by the very long "face," the deep preorbital.

Polysteganus praeorbitalis Günther.

(Pls. XXI and XXVIII and text-fig. 24.)

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 714.

1933. Fowler, U.S. Nat. Mus. Bull. 100, vol. xii, p. 119.

Dorsal profile of snout steep. Nape trenchant. Head characteristic, with long "face" due to deep preorbital.

Depth 2·5–2·8, length of head 3–3·2 in length of body. Eye 4·6–7·0, snout 2·1–2·5, interorbital 4·8–5, and postorbital 2·4 in length of head. Eye 1·6–2·0 in preorbital depth. Preopercle margin feebly serrate in juveniles. Mouth fairly large, maxilla extends to below anterior nostril. Lower jaw projects somewhat. In upper jaw 4 canines, widely spaced, outer pair large, inner smaller. In lower jaw 6, widely spaced, outer 2 pairs subequal, not as large as outer of upper jaw, inner pair smaller. Lateral teeth conical and fairly stout. An inner narrow band of fine conical teeth in each jaw. 15–16 gill-rakers on lower limb of anterior arch, slender. Posterior nostril oval.

D XII, 10: inserted just behind opercular margin. 1st spine 5·4–5·8, 2nd 3·2, 3rd 2·6, 4th and 5th subequal, 2·4–2·5 in head. Base of soft fin half that of spinous. Soft rays little higher than last spines, edge of fin gently rounded. A III, 8: inserted below the base of the 1st dorsal ray. Edge of fin gently convex. Pectoral 1–1·2 in head, tip reaches just beyond anal origin. Ventrals 1·7 in head, do not reach vent.

Scales ctenoid (Pl. XXVIII, figs. 4 and 5), those above the lateral line of diameter less than half of those on flanks. Lateral line tubes narrow, oblique, with 2 diverging series of pores behind (Pl. XXI, fig. 6). l.l. 59–63, l.tr. $\frac{11\text{–}12}{16}$, 11–12 cheek scales. Preopercle flange scaly, only narrow

margin naked. Scales on opercle very small. Interorbital completely scaly, scaling on head extends to above anterior nostril. Soft dorsal and anal naked, with deep and heavy scaly sheath, much heavier than in any other species of *Polysteganus* Klunz.

Colour.—(Just after death) Reddish with yellow tinge; a bluish band along dorsal base. Faint series of bluish dots along body. A bluish

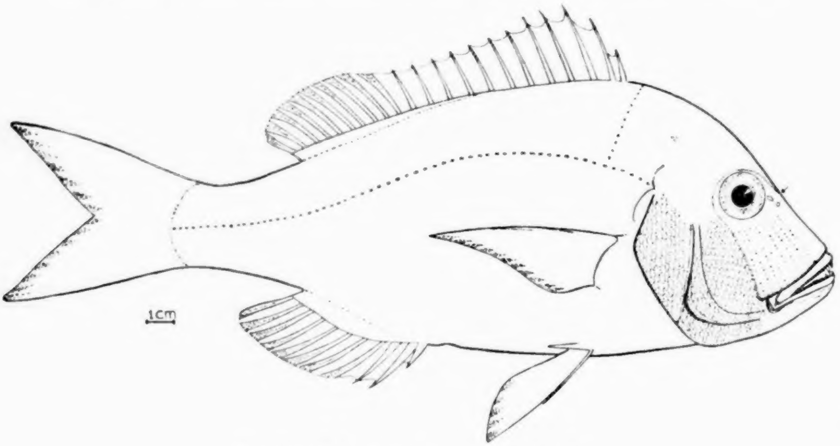

FIG 24.—*Polysteganus praeorbitalis* Günther.
The rows of dots show number and disposition of scale rows. The small arrow shows anterior margin of scaling on head.

streak above and at side of eye. Fins pink or yellow. Preserved specimens usually fade to uniform light red-brown, longitudinal lines showing on the scale rows.

Length.—Up to 500 mm.

Locality.—Algoa Bay to Natal and Zululand, in moderately deep water, down to 50 fathoms.

P. praeorbitalis can never be confused with any other known species from South Africa. It is the Denticid analogue of the Sparid *Chrysoblephus anglicus* G. & T., both having the deep preorbital, but the latter has a more abrupt profile of the snout and molariform teeth.

This species is taken on lines from boats in fairly deep water and is generally more plentiful during the winter months.

Genus *Petrus* n.g.

Body oblong-elongate, fairly compressed. Eye rather small. Preorbital depth greater than eye. Prefrontals usually enlarged, forming a

prominent antorbital ridge. Posterior nostril oval. Mouth large, canines very strong, also lateral teeth. Gill-rakers few, short, wide, laminate (fig. 25). 11 dorsal spines, graduated.

Scales ctenoid, moderate, those above the lateral line less than half width of those below. Interorbital scaly, but scaling not continuous across full extent, comes to an apex scarcely in advance of eye. Preopercle limb only partly scaly. Soft dorsal and anal with heavy fleshy bases, without basal sheaths, and densely scaly basally. Cheek scales very small.

Genotype *rupestris* Valenciennes, monotypic and endemic.

It is remarkable that this genus has not previously been proposed. The peculiar gill-rakers, so different from the usual lanceolate shape characteristic of all other South African members of the family, would alone almost justify the step. In addition is the nature of the soft dorsal and anal fins. There is no basal sheath, the bases of the rays being elevated in a fleshy base above the dorsal profile, and that base and the basal portion of the rays themselves are densely scaly. Certainly *Petrus* can never be held identical with *Dentex* Cuv. nor with any other South African genera of the Denticidae. Other supporting features are the 11 dorsal spines, the nature of the interorbital scaling, the very small cheek scales, and the enlarged prefrontals.

Petrus rupestris Valenciennes.

(Pls. XXI and XXVII and text-fig. 25.)

1927. Barnard, Ann. S.A. Mus., vol. xxi, p. 713.

Dorsal profile of snout fairly abrupt, antorbital ridges prominent. Depth 2·9–3·1, length of head 3–3·2 in length of body. Eye 4(juv.)–8, snout 1·8–2·1, interorbital 3·5–4, and postorbital 2·8 in length of head. Eye 1·4–2·1 in preorbital depth. Lower margin of preorbital slightly undulate. Posterior nostril oval. Preopercle margin round angle feebly serrate in juveniles. Mouth rather large, maxilla end not entirely concealed beneath preorbital. Maxilla extends to almost below anterior nostril. Jaws equal, in upper 4 canines, outer large, inner smaller, in lower 4–6, hinder larger. Fine teeth in a narrow band in each jaw, inner hinder obtuse, almost molariform. Outer lateral teeth conical. Gill-rakers short, laminate, 8–9 on lower limb of anterior arch (fig. 25).

D XI, 10–11: inserted above behind hind opercular margin. Spines fairly stout. 1st 7–7·4, 2nd 5·5, 3rd 3·7, 4th and 5th longest, 3·2 in head. Soft rays longer than last spine, longest 3·1 in head, edge of fin gently convex. Base of soft fin 2·2 in base of spinous.

A III, 8: inserted below the base of the 2nd dorsal ray. 2nd spine

much shorter than 3rd, but slightly stouter. Pectoral 1·2–1·4 in head, does not reach above vent. Ventrals 2·2 in head, do not reach vent. Caudal moderately forked.

Scales moderate, ctenoid (Pl. XXVII, figs. 4 and 5), those above the lateral line less than half the width of those below. Lateral line tubes oblique and fairly slender, with one or more large pores behind (Pl. XXI, fig. 1). l.l. 57–63, l.tr. $\frac{11\text{–}12}{19\text{–}20}$, 17–18 series on cheek. Preopercle flange partly scaly, a wide margin naked. Interorbital partly scaly, scales on head come to a point above or just beyond above the anterior margin of the eye.

Colour.—Red to bronzy, with metallic sheen above, lighter below.

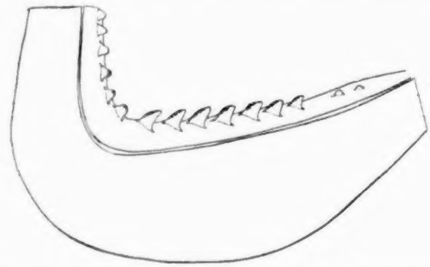

FIG. 25.—First gill-arch of *Petrus rupestris* Val., from specimen 725 mm. total length.

Jaws with yellow tinge. A dark interorbital band, tending to fade. Fins variably reddish.

Length.—Up to 1800 mm.

Locality.—Cape Peninsula to Natal, chiefly on rocky banks. Occasionally enters the mouths of deeper tidal rivers in pursuit of food.

A well-known species which merits full generic distinction from all other Denticid fishes. In many respects it stands as the Denticid analogue of the Sparid *Cymatoceps nasutus* Cast. Both are solitary species of almost similar habits and habitat, which grow to a large size.

P. rupestris ranks high among the angling fishes of South Africa, the capture of a large specimen being the ambition of most rodsters. Specimens of over 130 lbs. have been brought to the scale, but the species is stated to attain a much larger size. Old fishermen of the Agulhas Bank generally agree that the "Red Steenbras" grows to a length of over 6 feet and attains a weight computed at 300 lbs. or even more. *rupestris* is stated to be exceedingly vicious, and cases have been reported of swimmers having been attacked by large specimens. I have known a specimen just landed to snap off the top of a man's finger.

I wish to express my gratitude to the Research Grant Board of South Africa (Carnegie Fund) for generous financial assistance. Also to Dr. Barnard, Assistant Director of the S.A. Museum, for his continual kindness in making copies of figures and extracts from literature not available here. To Dr. Barnard, Colonel Norman of the British Museum, and Dr. de Beaufort, Director of the Zoological Museum, Amsterdam, for the loan of valuable material. Also to Mr. Bell Marley, Principal Fisheries Officer of Natal, without whose aid I should have found it exceedingly difficult to secure some of the rarer Natal species. And to many other friends whose enthusiasm has secured valuable specimens.

To Miss Rothmann, M.Sc., I am indebted for the preparation of text-figs. 1 and 2.

ALBANY MUSEUM,
GRAHAMSTOWN,
May 1937.

EXPLANATION OF LEGENDS TO PLATES.

PLATES XVIII–XXII.—LATERAL LINE SCALES.

E.g. "1. *Austrosparus auriventris* Peters, 7th (180). × 13," indicates that fig. 1 shows the 7th lateral line scale of that species, taken from a specimen 180 mm. standard length, and that the linear magnification is 13.

PLATES XXIII–XXIX.—ORDINARY SCALES.

In all cases scales A are taken from midway between the anterior part of the base of the spinous dorsal and the lateral line. Scales B are taken from midway between the lateral line and the origin of the anal fin.

E.g. "1. *Austrosparus auriventris* Peters, A (180). × 8," indicates that fig. 1 shows a scale of that species from above the lateral line below the origin of the spinous dorsal, taken from a specimen 180 mm. standard length, and that the linear magnification is 8.

In all cases the posterior margin of the scale is below.

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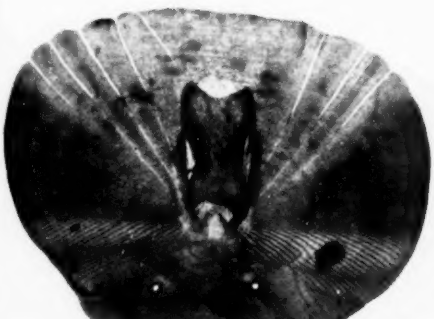

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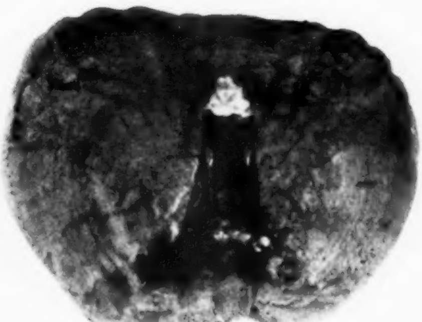

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Lateral line scales of Sparid Fishes. Posterior margin below.

1. *Austrosparus auriventris* Peters, 7th (180). × 13.
2. *Acanthopagrus berda* Forsk., 15th (180). × 7·5.
3. *Austrosparus sarba* Forsk., 7th (190). × 11.
4. *Sparodon durbanensis* Cast., 20th (170). × 10.
5. *Austrosparus globiceps* Cuv., 12th (135). × 16.
6. *Acanthopagrus bifasciatus* Forsk., 10th (165). × 9.

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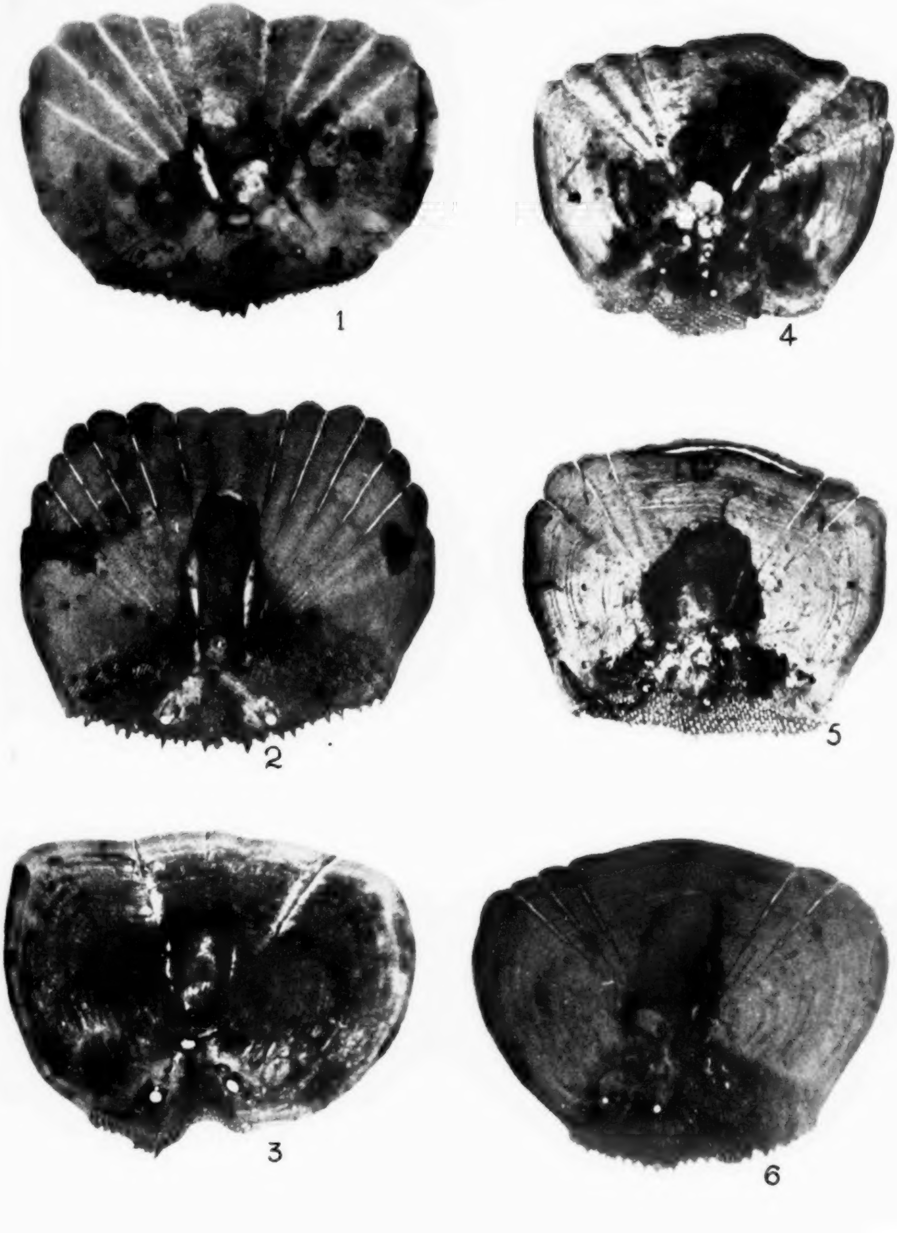

Lateral line scales of Sparid Fishes. Posterior margin below.

1. *Diplodus sargus* Linn., 45th (175). × 15.
2. *Diplodus trifasciatus* Raf., 56th (150). × 17.
3. *Pterogymnus laniarius* Cuv., 18th (290). × 8.
4. *Chrysoblephus anglicus* G. and T., 15th (315). × 9.
5. *Chrysoblephus laticeps* Cuv., 15th (350). × 8.
6. *Chrysoblephus gibbiceps* Cuv., 12th (220). × 9.

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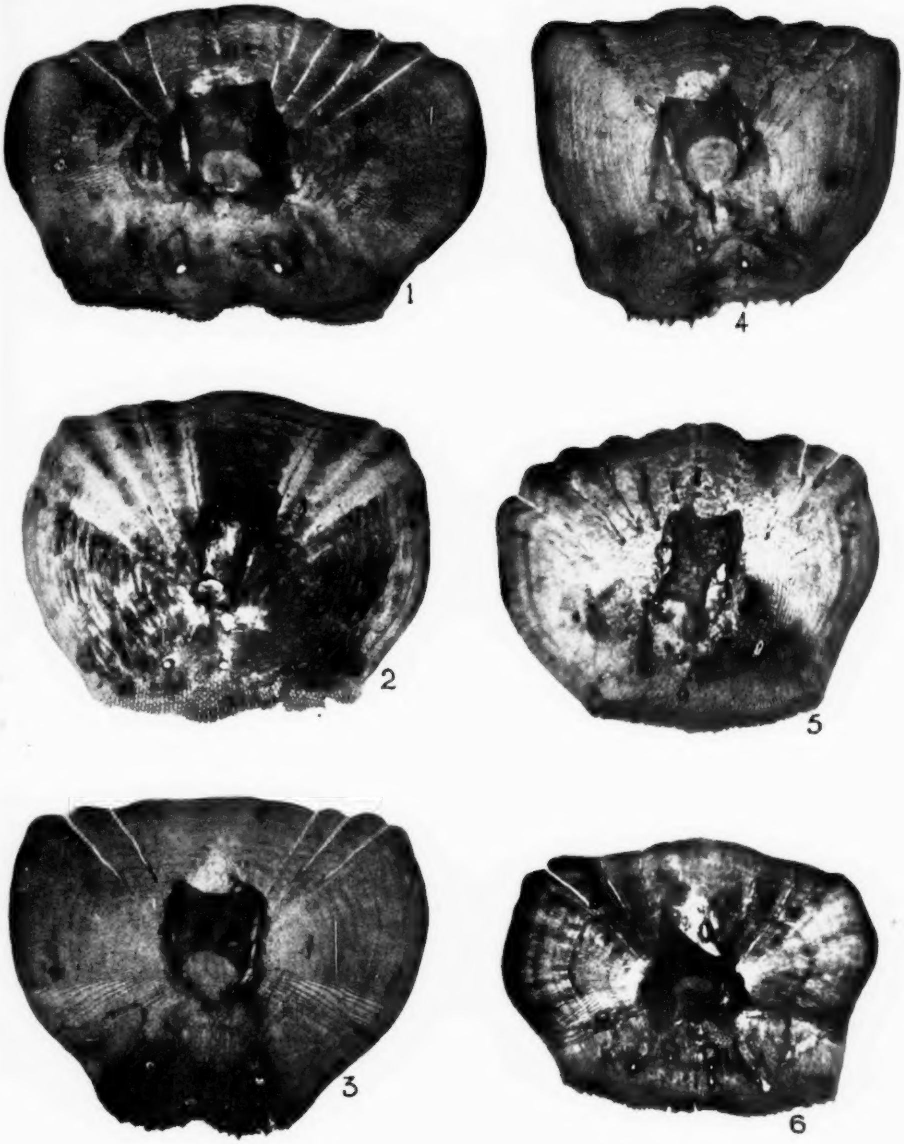

Lateral line scales of Sparid Fishes. Posterior margin below.

1. *Pagellus natalensis* Stndr., 7th (175). × 12.
2. *Chrysoblephus cristiceps* Cuv., 10th (300). × 7.
3. *Argyrops spinifer* Forsk., 10th (110). × 16.
4. *Porcostoma dentata* G. and T., 30th (230). × 21.
5. *Cymatoceps nasutus* Cast., 20th (280). × 8·5.
6. *Lithognathus mormyrus* Linn., 9th (240). × 11.

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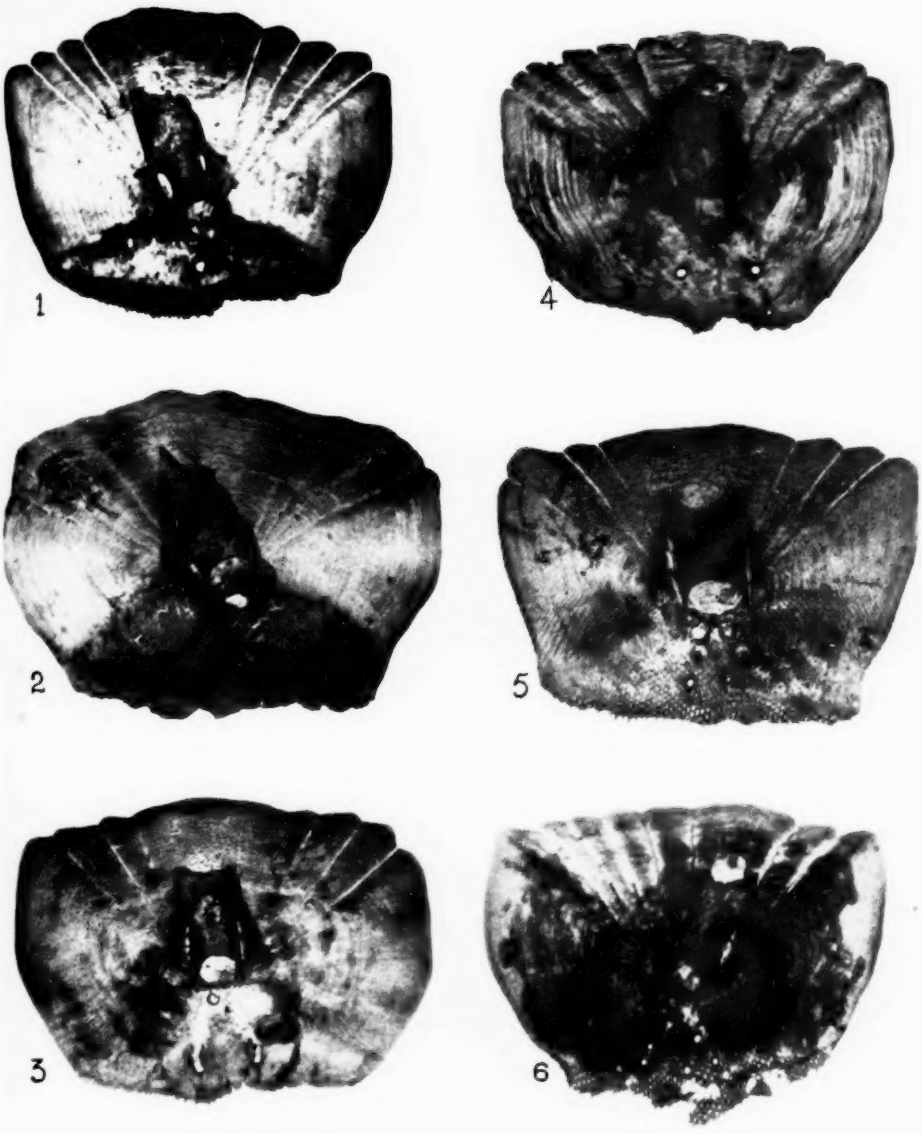

Lateral line scales of Sparid and Denticid Fishes.

1. *Petrus rupestris* Val., 15th (450). × 7.
2. *Gymnocranius robinsoni* G. and T., 16th (300). × 7.
3. *Cheimerius nufar* Val., 15th (250). × 9.
4. *Polysteganus argyrozona* Val., 10th (200). × 9.
5. *Polysteganus undulosus* Rgn., 10th (200). × 13.
6. *Polysteganus praeorbitalis* Gnthr., 10th (300). × 8.

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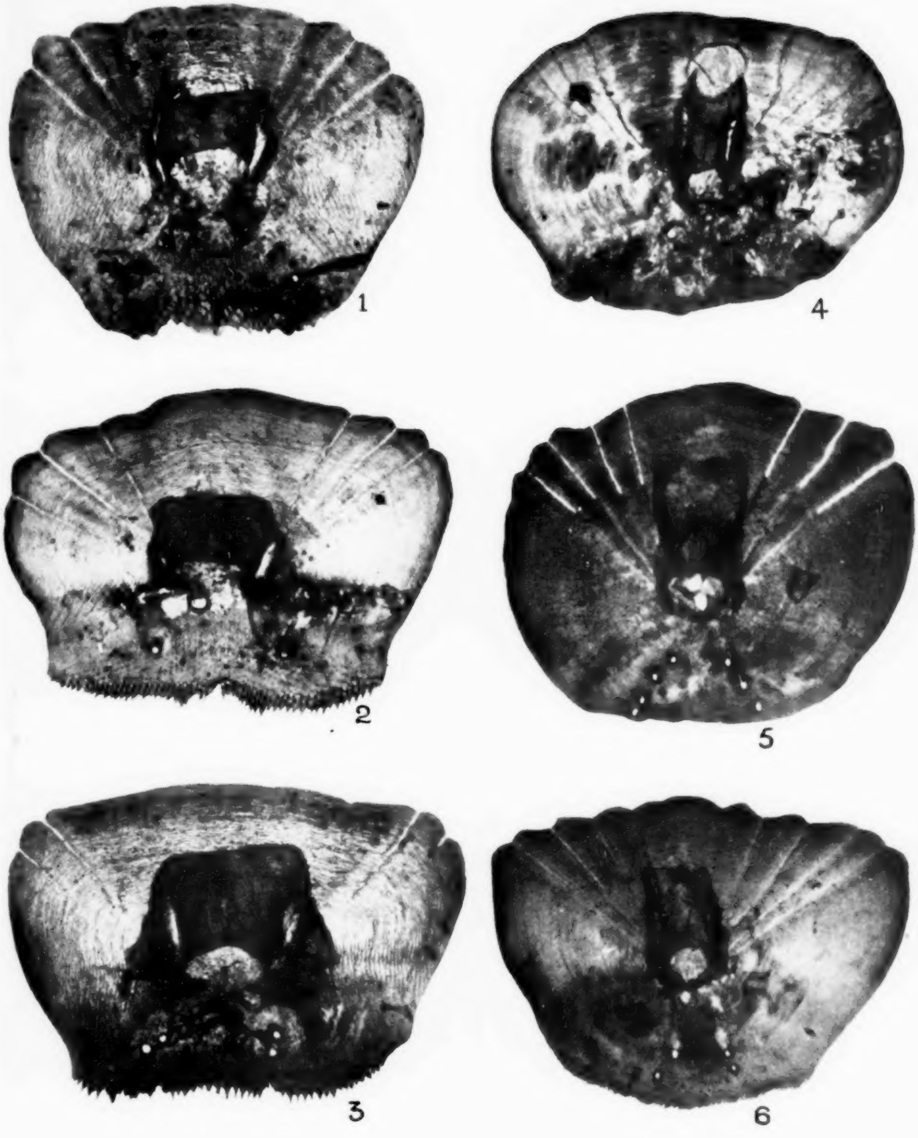

Lateral line scales of Sparid and Denticid Fishes.

1. *Boopsoidea inornata* Cast., 10th (140). × 21.
2. *Spondyliosoma emarginata* Cuv., 10th (150). × 13.
3. *Pachymetopon blochii* Val., 10th (160). × 20.
4. *Pachymetopon aeneum* G. and T., 10th (350). × 6.
5. *Crenidens crenidens* Forsk., 9th (135). × 13.
6. *Polysteganus coeruleopunctatus* Klunz., 10th (230). × 9.

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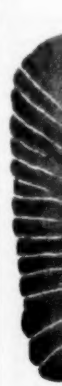

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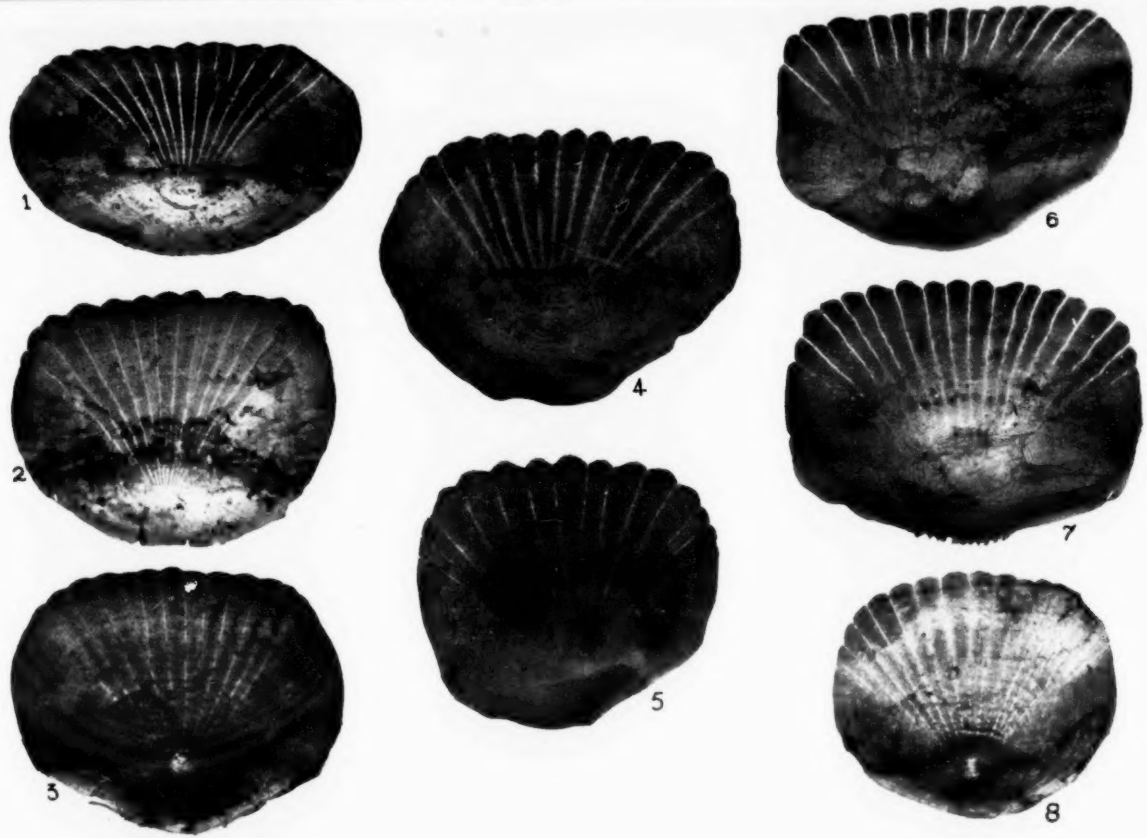

Scales of Sparid Fishes.

1. *Austrosparus auriventris* Peters., A. (180). × 8.
2. *Austrosparus auriventris* Peters., B. (180). × 6.
3. *Austrosparus sarba* Forsk., A. (190). × 5.
4. *Sparodon durbanensis* Cast., A. (170). × 8·5.
5. *Sparodon durbanensis* Cast., B. (170). × 6.
6. *Austrosparus globiceps* Cuv., A. (135). × 12.
7. *Austrosparus globiceps* Cuv., B. (135). × 11.
8. *Austrosparus sarba* Forsk., B. (190). × 6.

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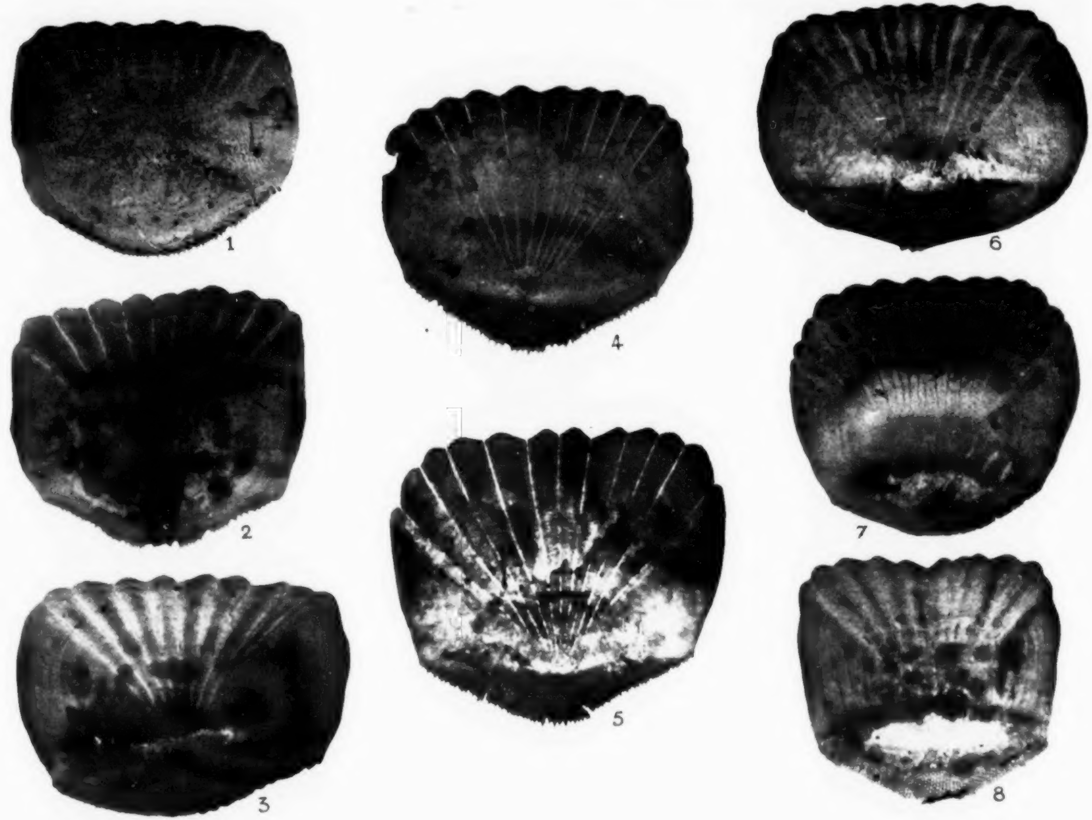

Scales of Sparid Fishes.

1. *Diplodus sargus* Linn., A. (175). × 12.
2. *Diplodus sargus* Linn., B. (175). × 10.
3. *Chrysoblephus anglicus* G. and T., A. (315). × 8.
4. *Diplodus trifasciatus* Raf., A. (150). × 12.
5. *Diplodus trifasciatus* Raf., B. (150). × 13.
6. *Acanthopagrus bifasciatus* Forsk., A. (165). × 8·5.
7. *Acanthopagrus bifasciatus* Forsk., B. (165). × 7.
8. *Chrysoblephus anglicus* G. and T., B. (315). × 8.

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Scales of Sparid Fishes.

1. *Argyrops spinifer* Forsk., A. (110). × 11.
2. *Argyrops spinifer* Forsk., B. (110). × 12.
3. *Cymatoceps nasutus* Cast., A. (280). × 10.
4. *Pterogymnus laniarius* C. and V., A. (290). × 7.
5. *Pterogymnus laniarius* C. and V., B. (290). × 7.
6. *Porcostoma dentata* G. and T., A. (230). × 18.
7. *Porcostoma dentata* G. and T., B. (230). × 18.
8. *Cymatoceps nasutus* Cast., B. (280). × 7.

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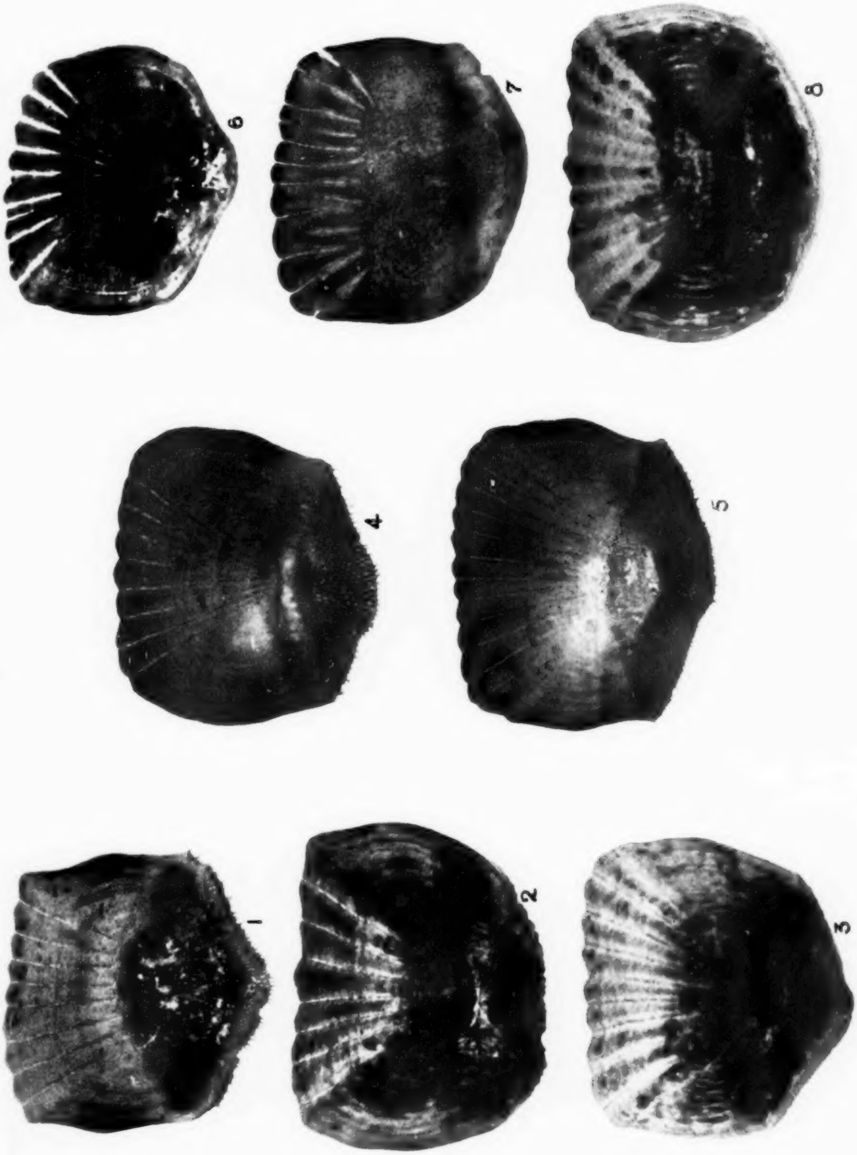

Scales of Sparid Fishes.

1. *Chrysoblephus laticeps* Cuv., A. (150). ×9.
2. *Chrysoblephus laticeps* Cuv., B. (350). ×6.
3. *Chrysoblephus cristiceps* Cuv., B. (300). ×5.
4. *Chrysoblephus gibbiceps* Cuv., A. (220). ×9.
5. *Chrysoblephus gibbiceps* Cuv., B. (220). ×7.
6. *Crenidens crenidens* Forsk., A. (135). ×7·5.
7. *Crenidens crenidens* Forsk., B. (135). ×6·5.
8. *Chrysoblephus cristiceps* Cuv., A. (300). ×5·5.

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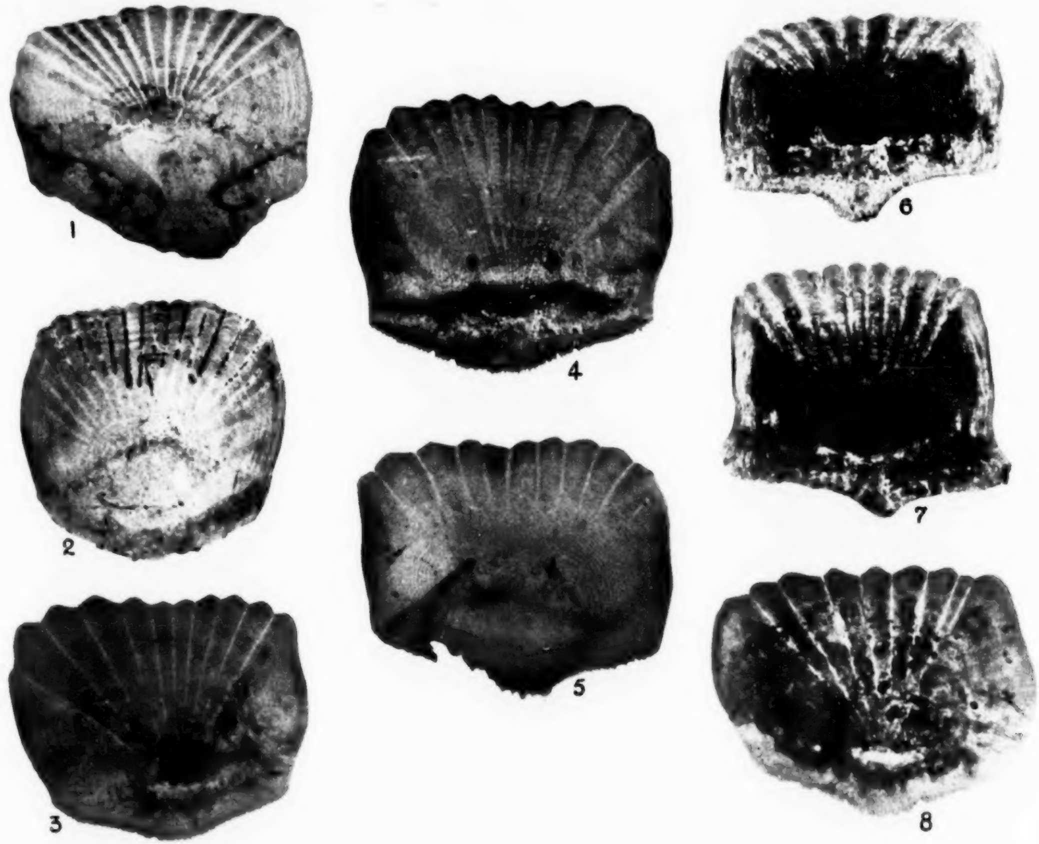

Scales of Denticid Fishes.

1. *Gymnocranius robinsoni* G. and T., A. (300). × 5.
2. *Gymnocranius robinsoni* G. and T., B. (300). × 5.
3. *Cheimerius nufar* C. and V., A. (250). × 7.
4. *Petrus rupestris* C. and V., B. (450). × 5.
5. *Petrus rupestris* C. and V., A. (450). × 9.
6. *Polysteganus argyrozona* C. and V., A. (300). × 8.
7. *Polysteganus argyrozona* C. and V., B. (300). × 6.
8. *Cheimerius nufar* C. and V., B. (250). × 7.

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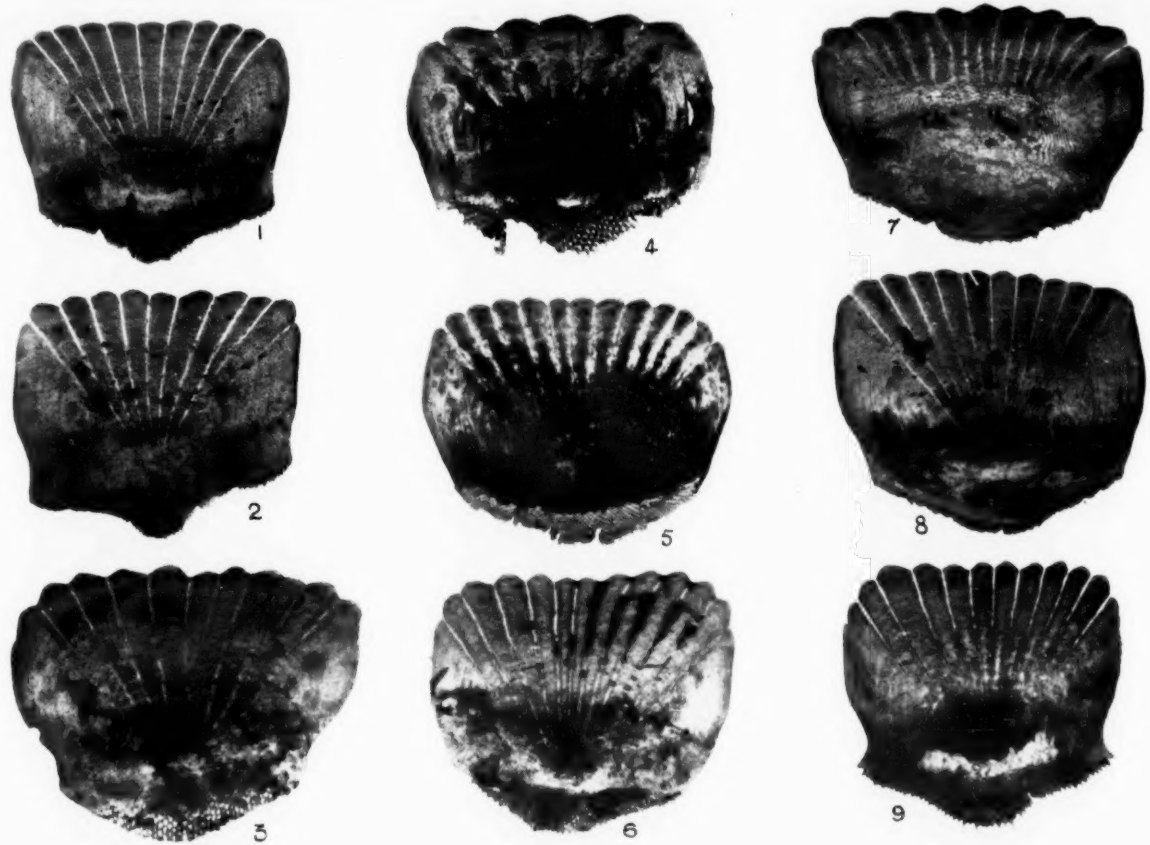

Scales of Sparid and Denticid Fishes.

1. *Polysteganus undulosus* Rgn., A. (200). × 7.
2. *Polysteganus undulosus* Rgn., B. (200). × 12.
3. *Boopsoidea inornata* Cast., A. (140). × 15.
4. *Polysteganus praeorbitalis* Gnthr., A. (300). × 12.
5. *Polysteganus praeorbitalis* Gnthr., B. (300). × 5·5.
6. *Boopsoidea inornata* Cast., B. (140). × 12.
7. *Polysteganus coeruleopunctatus* Klunz., A. (230). × 9.
8. *Polysteganus coeruleopunctatus* Klunz., B. (230). × 6.
9. *Pachymetopon blochii* Val., A. (160). × 15.

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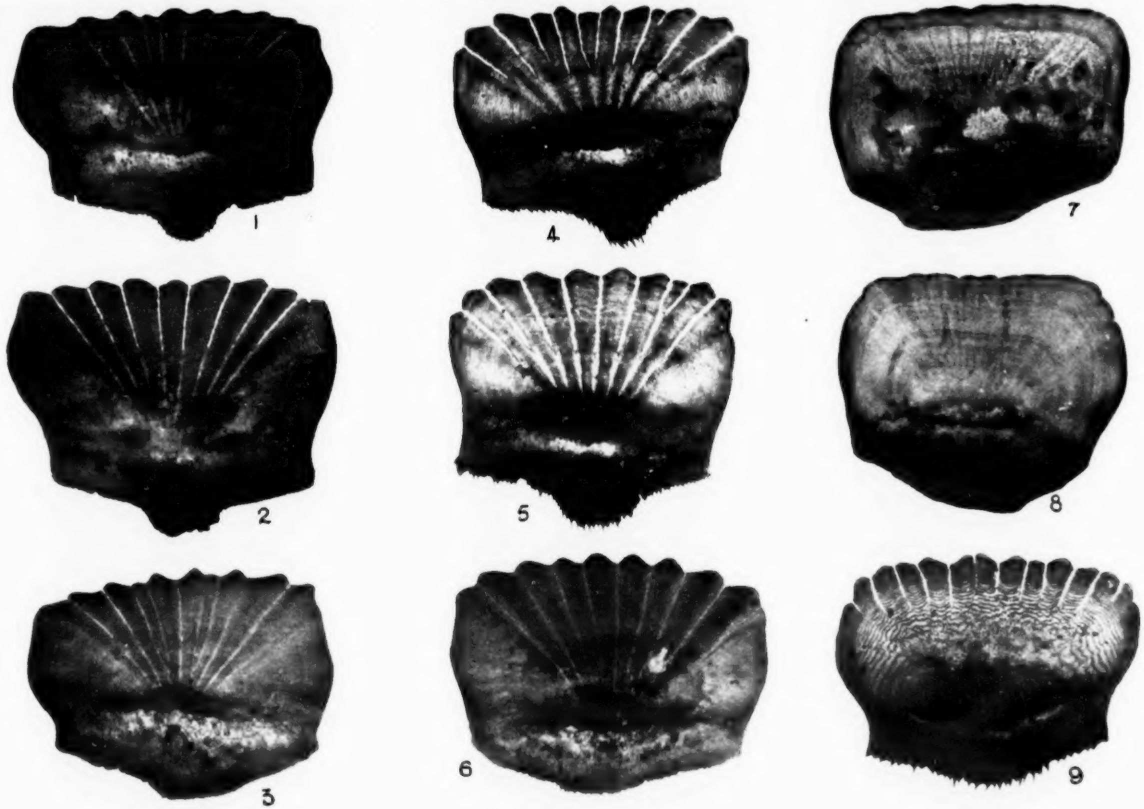

Scales of Sparid Fishes.

1. *Pagellus natalensis* Stndr., A. (175). × 12.
2. *Pagellus natalensis* Stndr., B. (175). × 10.
3. *Lithognathus mormyrus* Linn., A. (240). × 9.
4. *Spondyliosoma emarginata* Cuv., A. (150). × 16.
5. *Spondyliosoma emarginata* Cuv., B. (150). × 12.
6. *Lithognathus mormyrus* Linn., B. (240). × 8.
7. *Pachymetopon aeneum* G. and T., A. (350). × 5·5.
8. *Pachymetopon aeneum* G. and T., B. (350). × 4·5.
9. *Pachymetopon blochii* Val., B. (160). × 16.

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THE EVOLUTION OF A GROWTH-INHIBITING EMANATION FROM RIPENING PEACHES AND PLUMS.

By WM. EDWYN ISAAC,

Government Low-Temperature Research Laboratory, Cape Town.

(With Plates XXX–XXXIII.)

It has been established that during ripening, certain fruits (especially apples) produce a gas which stimulates the ripening of other fruits and inhibits the growth of certain seedlings and the sprouting of potatoes. The following investigation was undertaken to ascertain whether a similar substance is produced by peaches and Japanese varieties of plum. There is no previously published account of peach or plum emanations which retard the growth of seedlings and the sprouting of potatoes, but attention may be called to the statement by Kidd and West (1933) that an unidentified volatile product of ripe peaches hastens the onset of the climacteric in unripe apples.

Positive results were obtained with the peaches and plums tested, but the writer considers it important at the outset to emphasise the consideration that until definite tests have been made, it cannot be assumed that the effects established under ordinary room conditions in summer, and the conclusions drawn therefrom, are true of the low-temperature conditions obtaining during the storage and transport of fruit to distant markets. Later, it is intended to investigate this problem.

METHODS.

The experiments here recorded were carried out at ordinary laboratory temperatures, in Cape Town, during the summer season of 1936–37.

Inkoos, Peregrine, and Elberta peaches and Santa Rosa and Wickson plums were tested with regard to their effects on certain seedlings. Seedlings of Canadian wonder bean (*Phaseolus vulgaris*) were mostly used, but also the broad bean (*Vicia Faba*) and the sunflower (*Helianthus annuus*). Some experiments were also made with sprouting potatoes.

A large sample of seeds of reasonably uniform size was washed first in distilled water, and then for five minutes in a 0·1 per cent. solution of mercuric chloride. After being allowed to soak in water for at least

twenty-four hours they were transferred to wads of moist filter-paper in desiccators. The filter-paper was kept moist with distilled water saturated with calcium carbonate. The seeds were then left to germinate for two or three days until a sufficient number of seedlings had a radicle length of about 1·1 to 2·6 cm. For each experiment as homogeneous a sample of seedlings as possible was chosen in respect of radicle length. Seedlings with somewhat longer radicles were used as experimental material, the seedlings with smaller radicles as controls. Thus, the results contained in this paper are always a minimum statement of the effects of fruit emanations.

The exact assembly of apparatus varied in different experiments, but the following remarks apply in every case. A continuous stream of air was drawn over fruit and seedlings by means of a filter-pump. The incoming air-stream was first bubbled through bromine water to remove any traces of ethylene which might be present in the air, and was then passed through a strong solution of caustic soda to absorb the bromine vapour drawn over from the bromine water. The carbon dioxide evolved by fruit or seedlings was absorbed from the air-stream by a strong solution of caustic soda immediately on leaving the desiccator containing the respiring material. Precautions were taken to prevent the accumulation of water around the germinating seedlings.

Experimental Results.

(a) *Morphological Effects.*—The control seedlings of the Canadian wonder bean showed good growth in a period of eight to nine days. The length of the region from the base of the hypocotyl to the tip of the epicotyl was of the order of 6 to 8 inches. The epicotyl bore one pair of expanded leaves, while the cotyledons presented a somewhat shrivelled appearance. The root system was well developed, and there was an abundance of secondary roots.

Seedlings grown for two or three days in air, and then grown in an air-stream which was first passed over ripening fruit, showed decided differences as compared with the controls. The differences usually reached a maximum after the seedlings had been subjected to air drawn over fruit for about six days. The degree of difference then diminished. The growth in length of the hypocotyl was greatly retarded, but this was accompanied by an increased growth in thickness, the lower end tending to swell into a tuber-like structure. The epicotyl showed an even more reduced growth than the hypocotyl. The elongation of the main root was not retarded to the same extent as that of the aerial axis, but the growth in length of secondary roots was more affected than that of the

primary root. In addition to a decrease of growth in length, there was also a decrease in total growth, in spite of increased radial growth. More conclusive evidence of this will be given later (Table I). In most cases the hypocotyl showed a definite coiling. The epicotyl did not completely emerge from between the cotyledons, and in many cases the cotyledons did not completely throw off the testa.

The results of a typical experiment with Santa Rosa plums are illustrated in fig. 1. The effects illustrated and described above were to a greater or lesser degree constant for all the experiments in which Canadian wonder bean seedlings were used.

Sunflower seedlings showed similar but less striking responses (fig. 2). The control seedlings showed a good development of primary and secondary roots and also of the hypocotyl. During the experimental period the cotyledons did not become fully expanded, as the first functional leaves and the epicotyl remained undeveloped. In most cases the testa and pericarp were not completely thrown off. The experimental seedlings showed a reduction of growth in length and also a reduction of total growth, since there was no general increase in radial growth of the hypocotyl. A tuber-like swelling, however, was formed in the region of the lower end of the hypocotyl and the upper end of the primary root. As with the Canadian wonder bean, the hypocotyl was coiled and the growth of the primary root was relatively less affected than that of the hypocotyl. The secondary roots, however, showed much reduction in growth.*

Broad-bean seedlings were used in experimenting with Inkoos peaches. The result of one experiment, which was continued for six days, is shown in fig. 3. The control seedlings showed a limited epicotyl growth, but the primary and secondary roots were well developed. There were no fully expanded leaves. The epicotyl of the experimental seedlings showed no markedly inferior growth as compared with the controls, but the extent and character of the root system was different. The primary root attained a length of a third to a half of that shown by the controls. There was a tendency to radial thickening which was marked in some cases. The tips of the primary roots showed a tendency to become coiled, and in this respect showed a parallel behaviour to the hypocotyls of the Canadian wonder bean and the sunflower. The growth of secondary roots was inhibited to a greater extent than the growth of the primary root.

Positive results, using Canadian wonder beans, were also obtained with Peregrine and Elberta peaches (fig. 6) and Wickson plums.

* The Santa Rosa plums used for this experiment were from the same consignment of fruit as those used for the experiment illustrated in fig. 1. During the intervening week, the plums were kept under ordinary cold-storage conditions at 40° F. This was the only experiment conducted in which sunflower seedlings were used.

TABLE I.

SHOWING THE EFFECT OF THE ACTIVE SUBSTANCE PRODUCED BY PEACHES AND PLUMS IN REDUCING THE FRESH AND DRY WEIGHTS OF *PHASEOLUS VULGARIS* (VAR. CANADIAN WONDER) SEEDLINGS DIVESTED OF THEIR TESTAS.

Fruit variety.	Fresh weight per 100 seedlings.		Per cent. weight of experimental seedlings; control taken as 100 per cent.	Weight dried at 105° C. per 100 seedlings.		Per cent. weight of experimental seedlings; control taken as 100 per cent.
	Control.	Experimental.		Control.	Experimental.	
* Santa Rosa plums I .	138·8 gm.	66·6 gm.	48·0 per cent.	12·1 gm.	9·4 gm.	77·7 per cent.
Santa Rosa plums II	119·5 ,,	55·0 ,, †	46·0 ,, ‡	12·4 ,,	6·7 ,,	54·0 ,,
Peregrine peaches I .	107·5 ,,	61·4 ,, §	57·1 ,, ‖	12·1 ,,	8·15 ,,	67·4 ,,
Peregrine peaches II .	191·9 ,,	118·0 ,,	61·5 ,,	14·7 ,,	10·9 ,,	74·15 ,,
¶ Elberta peaches I .	90·65 ,,	67·6 ,,	74·6 ,,	8·75 ,,	8·1 ,,	92·6 ,,
Wickson plums I .	121·0 ,,	92·8 ,,	76·7 ,,	11·1 ,,	9·9 ,,	89·9 ,,
Wickson plums II .	213·0 ,,	133·1 ,,	62·5 ,,	..	..	..
Average . .	..	..	60·9 ,,	..	..	76 per cent.

* This experiment is illustrated in fig. 1.
† Six seedlings, two showing slight injury (fungal). Value on basis of four perfectly sound seedlings, 61·75 gm.
‡ The per cent. value corresponding to 61·75 gm. is 51·7.
§ Eight seedlings, two showing slight injury (fungal). Value on basis of six perfectly sound seedlings, 72·3 gm.
‖ The per cent. value corresponding to 72·3 gm. is 67·2.
¶ This experiment is illustrated in fig. 6.

(b) *Anatomical Effects.*—The most outstanding changes effected in the anatomy of the Canadian wonder bean hypocotyl are indicated below.

The cortex of the hypocotyl of the experimental seedlings had, in transverse section, a much greater radius as compared with the controls. In a few cases the radius was about three times as great. This enlargement was primarily, if not entirely, due to an increase in size of the individual cortical cells. The cambium was less well developed throughout in the experimental seedlings, and interfascicular activity was not evident. Lignification both in the xylem region and in the pericycle is a prominent

TABLE II.

WATER CONTENT OF NORMAL *PHASEOLUS VULGARIS* (VAR. CANADIAN WONDER) SEEDLINGS AND OF SEEDLINGS SUBJECTED TO PEACH AND PLUM EMANATIONS.

Fruit variety used.	Percentage water (fresh-weight basis).		
	Control.	Experimental.	Difference.
Santa Rosa plums I	91·3	85·9	5·4
Santa Rosa plums II	89·6	87·8	1·8
Peregrine peaches I	88·7	86·7	2·0
Peregrine peaches II	92·4	90·8	1·6
Elberta peaches	90·4	88·0	2·4
Wickson plums	90·8	89·35	1·45

feature of the normal hypocotyl. In the basal region there are two almost continuous rings of lignified tissue, the pericycle fibres on the outside and xylem tissue on the inside. In the experimental seedlings lignification was much less evident, the lignified elements consisting mostly of the isolated groups of vessels. These features are illustrated in figs. 4 and 5.

An enlargement of the cortex and of the individual cortical cells was noted by Harvey and Rose in the roots of *Ailanthus*, *Catalpa*, *Hibiscus*, and tomato when subjected to air contaminated with illuminating gas. This effect was ascribed to the presence of ethylene (Harvey and Rose, 1915). The cortex of the sweet-pea epicotyl is similarly affected by ethylene (Harvey, 1915). In these cases the increase of the cortex was partly due to cell division and partly to an increase in the size of the cells.

(c) *Effects on Fresh and Dry Weights.*—In Table I are given the fresh- and dry-weight determinations of experimental and control seedlings divested of their cotyledons. It is evident that the emanations of the tested fruits bring about a decrease in the total amount of growth.

The differences in fresh weight, although decided, are less than might be expected from observation of the material. The maximum difference obtained (Santa Rosa II) was just over double. A second experiment (Santa Rosa I) gave only a slightly smaller difference. The minimum value for the ratio of the weight of control seedlings to the weight of experimental seedlings was 4 : 3. If the weight of the control seedlings is taken as 100, then the average weight of the experimental seedlings is 60·9, and thus the average percentage difference between them is 39·1, or approximately a ratio of 5 : 3.

The difference in the dry weights was decidedly less than the differences in fresh weight (Table I). The maximum difference is somewhat less than double (46 per cent.), but the minimum difference gives a ratio of approximately 10 : 9. The average difference is 24 per cent., which gives a ratio of 25 : 19, or approximately 5 : 4. Thus the tissues of the controls contain more water than the tissues of the experimental seedlings (Table II). Although the difference is small, it would appear to be significant, since it occurred in every case. The average difference in water content for the six sets of determinations is 2·44 per cent., but if the high value for Santa Rosa I is omitted, the average becomes 1·85 per cent. It may be noted that Elmer (1936) found that, on a fresh-weight basis, normal potato sprouts contained about 2 per cent. more water than the sprouts of potatoes subjected to ripening apples.

Fresh- and dry-weight determinations of cotyledons were carried out in the case of two experiments with Peregrine peaches (Table III). The results indicated that the difference in dry weight shown by control and experimental seedlings was due to a difference in the amount of food substances translocated from cotyledons to seedlings, since the dry weight of the cotyledons and seedlings together is approximately constant for both the experimental seedlings and the controls. The difference in total weight in the two separate experiments may be due to the use of two different consignments of seeds.

(d) *Nature of the Growth-inhibiting Emanation.*—Some chemical evidence was obtained indicating that the growth-inhibiting substance produced by ripening plums and peaches is ethylene. The general scheme of these experiments was as follows:—

Incoming air ⟶ Bromine water ⟶ Concentrated NaOH solution ⟶ Canadian wonder-bean seedlings I ⟶ NaOH solution ⟶ Ripening fruit ⟶ NaOH solution ⟶ Canadian wonder-bean seedlings II ⟶ NaOH solution ⟶ Bromine water (A) ⟶ NaOH solution ⟶ Canadian wonder-bean seedlings III ⟶ Filter-pump.

A consideration of this scheme will make it clear that Seedlings I are growing under control conditions, while Seedlings II are growing under

TABLE III.

SHOWING THE EFFECT OF THE ACTIVE SUBSTANCE PRODUCED BY PEACHES AND PLUMS IN REDUCING THE AMOUNT OF FOOD SUBSTANCE TRANSLOCATED FROM THE COTYLEDONS OF *PHASEOLUS VULGARIS* (VAR. CANADIAN WONDER) SEEDLINGS.

	Fresh weight.			Dried at 105° C.		
	Weight of seedling and cotyledons per 100 seedlings.	Weight of seedling alone per 100 seedlings.	Weight of cotyledons per 100 seedlings.	Weight of seedling and cotyledons per 100 seedlings.	Weight of seedling alone per 100 seedlings.	Weight of cotyledons per 100 seedlings.
I.						
Peregrine peaches—						
Control . .	158·0 gm.	107·5 gm.	50·5 gm.	30·6 gm.	12·1 gm.	18·5 gm.
Experimental .	128·8 ,,	61·4 ,,	67·4 ,,	31·55 ,,	8·15 ,,	23·4 ,,
II.						
Peregrine peaches—						
Control . .	244·2 ,,	191·9 ,,	52·3 ,,	24·6 ,,	14·7 ,,	9·9 ,,
Experimental .	184·6 ,,	118·0 ,,	66·6 ,,	26·7 ,,	10·9 ,,	15·8 ,,

the influence of ripening fruit. Unit A, containing bromine water, is situated between Seedlings II and III. If the active substance from the fruit is absorbed by the bromine water, Seedlings III should show a normal growth similar to that of the controls. This proved to be the case.

It was shown in previous experiments that sufficient of the growth-inhibiting substance was evolved during the ripening of from 800 to 950 grams of the peach and plum varieties tested, to affect the germination of seedlings in three consecutive desiccators.

The results of an experiment with Elberta peaches is shown in fig. 6. In this particular experiment, seedlings of the C group (Seedlings III) showed a somewhat better growth than those of the A group (Seedlings I). Similar results were obtained with Peregrine peaches.

(e) *Experiments with Sprouting Potatoes.*—The potato proved to be unsuitable for experimenting with peaches and Japanese plums, since the growth of sprouting potatoes is relatively slow, and the period over which growth-inhibiting emanations were evolved in effective concentrations was of short duration—at a maximum estimate, not exceeding seven days.

Positive results, however, were obtained with both Inkoos peaches and Santa Rosa plums, by replacing the first lot of fruit with a second at the end of a week, and thus subjecting the sprouting potatoes to fruit emanations continuously for about two weeks. The results of an experiment with Inkoos peaches is shown in fig. 7. The young potato plants subjected to the influence of the ripening peaches showed the stunted and tuberous type of growth described by Elmer (1932, 1936) for potatoes stored with apples.

(f) *Duration of the Effect of the Active Substance on Germinating Seedlings.*—From the present results it would appear that the growth-inhibiting substance from the fruits tested was produced only over a period of a few days—not more than seven. If seedlings were kept too long under the influence of air drawn over fruit, then the experimental seedlings grew at a sufficient rate to begin rapidly to diminish the difference in growth between control and experimental seedlings. This result was to be expected from previous work. Elmer (1936), using seed potatoes, and Smith and Gane (1932), working with pea seedlings (*Pisum sativum*), have shown that normal growth can be made to follow abnormal growth by subjecting growing material first to apple emanation and then to air; and conversely, abnormal growth succeeds normal growth if the growing material is first subjected to air and then to apple emanations.

In the presence of ethylene the epicotyl shows a diageotropic response to gravity. In the experiments described in this paper the epicotyl of the Canadian wonder bean showed a too limited growth for this response

to be apparent, but in a few cases where the experiment was continued beyond the stage of maximum difference between control and experimental seedlings, the response was observed.

Discussion.

It has been shown that ripening fruit belonging to a number of peach and plum varieties evolves a gaseous or volatile substance which considerably modifies the growth and behaviour of Canadian wonder-bean, broad-bean, and sunflower seedlings, and also of sprouting potatoes. The principal and constant responses are as follows:—

(i) A retardation of growth in length.

(ii) An increase in radial growth.

(iii) Abnormalities in the direction of growth in relation to gravity.
This is most clearly seen in the diageotropism of the epicotyl, but is also seen in the coiling of the roots (*Vicia Faba*) and of the hypocotyl (Canadian wonder bean and sunflower).

Most observations were made on the seedlings of the Canadian wonder bean, and in regard to this plant it was shown that the increase in radial growth of the hypocotyl was chiefly due to an absolute and relative increase in the extent of the cortical parenchyma, which was the result of an increase in the size of the cortical cells. By means of fresh- and dry-weight determinations it was also shown that the emanations of peaches and plums bring about a reduction in the total amount of tissue formed by Canadian wonder-bean seedlings. Lastly, it was shown that the growth-retarding emanation was absorbed by bromine water.

In 1932 Elmer demonstrated that the emanations of a number of varieties of ripening apples produced abnormal and retarded growth of potato sprouts of a number of potato varieties (Elmer, 1932). Similar tests with germinating seedlings were suggested by this work (Smith and Gane, 1932).

There were a number of previous investigations dealing with the effects of ethylene on the growth of seedlings which substantiated the view that the responses which the emanations of ripening fruit elicited in seedlings were due to the presence of ethylene. This gas in low concentrations brings about the following changes in germinating seedlings:—

(i) Growth in length is retarded.

(ii) There is increased growth in the transverse plane, which tends to result in tuber-like structures.
The increase in thickness would seem to be due chiefly to an increase in the extent of the cortex. This result is achieved, at least in large measure, by an increase in the size of the indi-

vidual cells of the cortical parenchyma (Harvey, 1915, fig. 2; Harvey and Rose, 1915).

(iii) The epicotyl ceases to be negatively geotropic and becomes diageotropic.

These effects are similar to those induced by the growth-inhibiting emanations of fruits.

Smith and Gane (1932) presented indirect chemical evidence indicating that ethylene is evolved from ripening apples. Elmer subsequently extended his work and also presented chemical evidence for regarding ethylene as the effective agent (1936). Definite proof in the case of the English Worcester Pearmain apple was furnished by Gane (1935), who synthesised ethylene dibromide (which was isolated as diphenyl-ethylene-diamine) by passing air drawn over ripening apples through bromine.

Summary.

1. The following fruit varieties were tested for growth-inhibiting emanations: Inkoos, Peregrine, and Elberta peaches; Santa Rosa and Wickson plums. A positive result was obtained in every case.

2. Ripening peaches and plums produce an active substance which induces the following responses in sprouting potatoes and the seedlings of *Phaseolus vulgaris*, sunflower, and broad bean:—

(i) A retardation of growth in length.

(ii) Increased radial growth.

(iii) Abnormalities in the direction of growth in relation to gravity.

3. The following responses were also shown for the Canadian wonder bean (*Phaseolus vulgaris*):—

(iv) A reduction in both fresh and dry weight and a decrease in water content.

(v) A reduction of lignified tissue and of cambium in the hypocotyl, the interfascicular cambium in particular, being affected.

4. It was shown for *Phaseolus vulgaris* that the increased radial growth of the hypocotyl is chiefly due to an increase in the relative and absolute extent of the cortex, resulting from an increase in the size of the cortical cells.

5. Bromine water absorbs the growth-inhibiting substance.

6. The morphological, tropistic, and chemical evidence presented indicates the active substance to be ethylene.

Fig. 4 was taken by Dr. R. G. Nel, and the other photographs by Mr. D. J. R. de Villiers.

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FIG. 1.—Effect of a substance produced by ripening Santa Rosa plums on the growth of *Phaseolus vulgaris* (var. Canadian wonder) seedlings.

A. Control seedlings.
B. Seedlings exposed to air drawn over the plums for six days.

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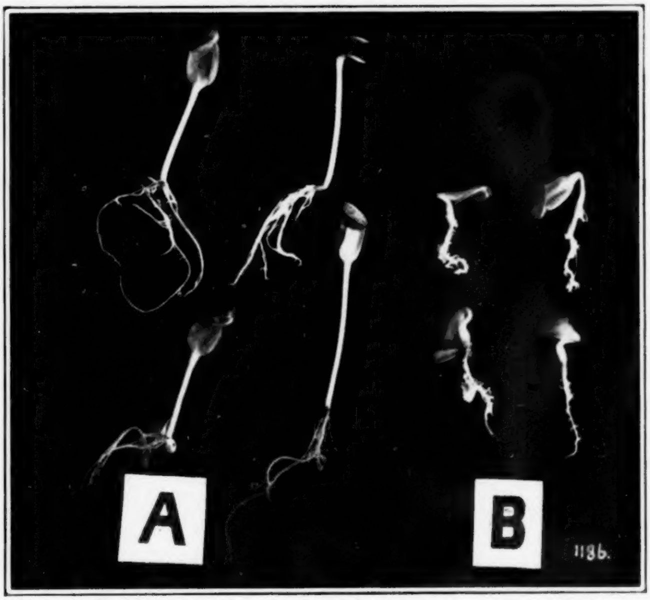

FIG. 2.—Effect of a substance produced by ripening Santa Rosa plums on the growth of sunflower seedlings.

A. Control seedlings.
B. Seedlings exposed to air drawn over the plums for six days.

FIG. 3.—Effect of a substance produced by ripening Inkoos peaches on the growth of broad-bean seedlings.

A. Control seedlings.
B. Seedlings exposed to air drawn over the peaches for six days.

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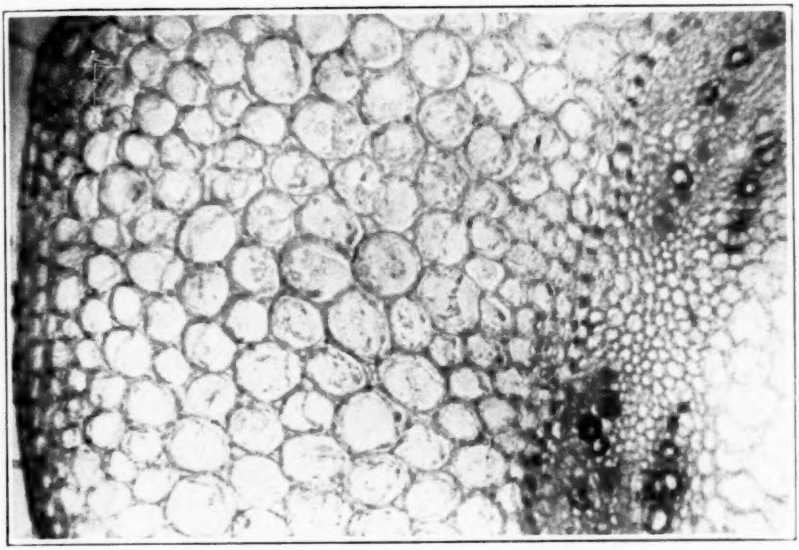

Fig. 5.—Transverse section through the basal region of the hypocotyl of a *Phaseolus vulgaris* (var. Canadian wonder) seedling which has been subjected for six days to the emanation from ripening Wickson plums. Note the larger cortex and larger cortical cells. Also the absence of pericycle fibres, the reduced lignification of the xylem region, and the absence of interfascicular activity.

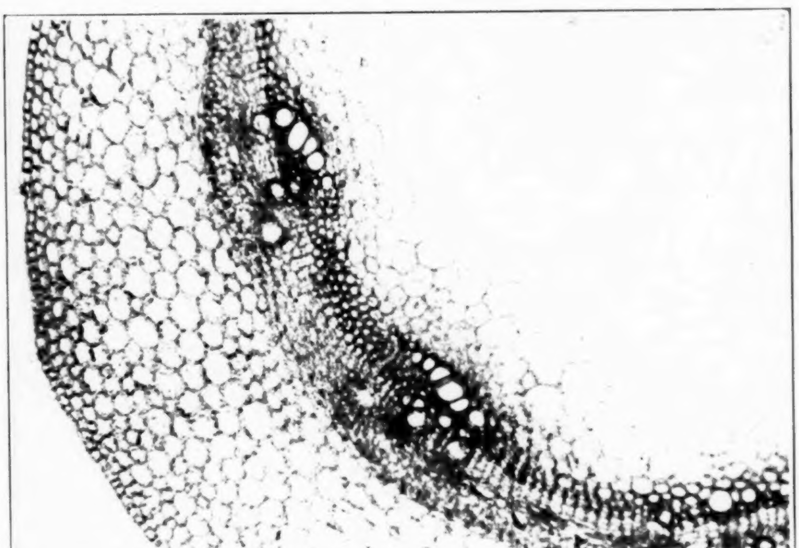

Fig. 4.—Transverse section through the basal region of the hypocotyl of a *Phaseolus vulgaris* (var. Canadian wonder) seedling.

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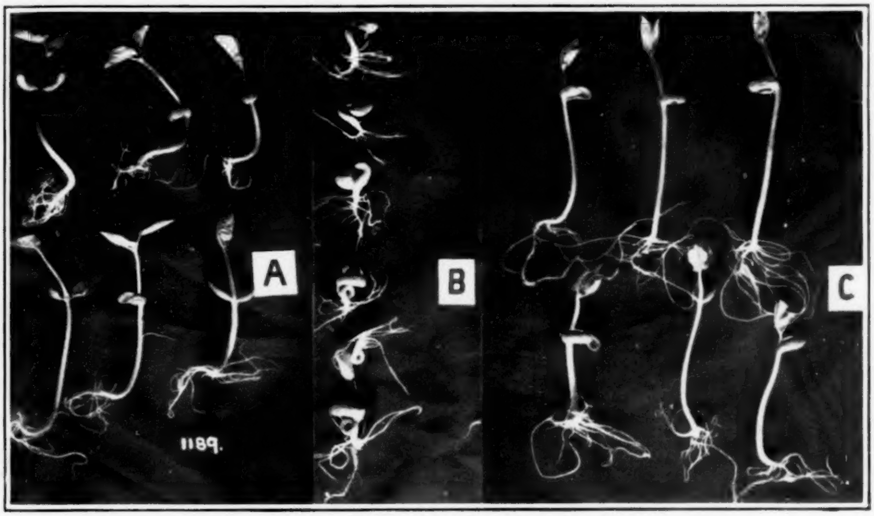

FIG. 6.—An experiment showing that the growth-inhibiting substance from Elberta peaches is absorbed by bromine water.

A. Control seedlings.
B. Seedlings of *Phaseolus vulgaris* (var. Canadian wonder) exposed to air drawn over the peaches for six days.
C. Seedlings of *Phaseolus vulgaris* (var. Canadian wonder) exposed to the same air-stream after it has passed through bromine water.

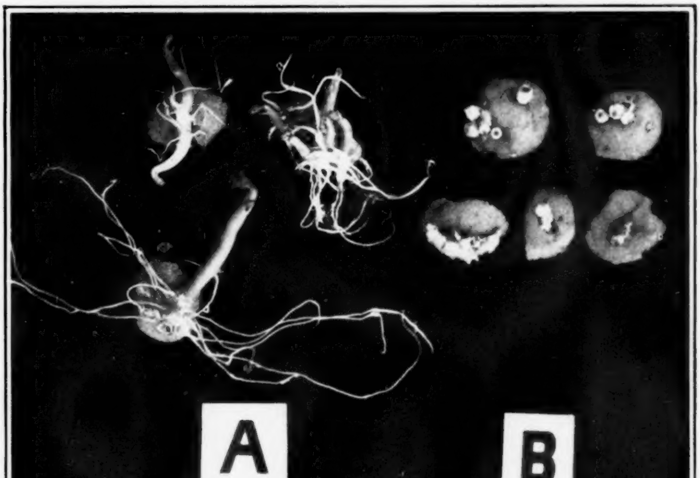

FIG. 7.—Effect of substance produced by ripening Inkoos peaches on the growth of potato sprouts.

A. Control sprouts.
B. Sprouts subjected to air drawn over the peaches for twelve days.

A NEW GOBIOID FISH FROM SOUTH AFRICA.

By J. L. B. Smith.

(With one Text-figure.)

Family Gobiidae.

Gobius keiensis n. sp.

Body rather elongate and slender, tapering gently from shoulder. Snout fairly blunt, upper lip protrudes, some degree of simocephaly.

Depth 5·5, length of head 3·6 in length of body. Eye 5·7, snout 3·2, and postorbital 1·8 in length of head. Interorbital very narrow, eyes almost contiguous. Head 1·7 times as long as deep. Least depth of preorbital equal to vertical diameter of orbit. Eye inserted in first third of head. Front of snout somewhat rugose.

Mouth fairly large, maxilla extends more than an eye diameter behind eye. Lips, especially upper, protrude somewhat. Hind end of maxilla acute, exposed. Teeth villiform, outer series but little enlarged, curved. No canines. Tongue bilobed. Papillae on cheeks very faint, discernible only with difficulty. The rows are mainly almost vertical, with one or two transverse rows running obliquely backwards. The effect is somewhat irregularly reticulate. Gill-openings restricted, membranes fused with isthmus. 8–9 rather small gill-rakers on the lower limb of the anterior arch. No shoulder flaps.

D VI + I 12. First dorsal inserted behind above hind margin of opercle. Spines of first dorsal filamentous, 1st 4, 2nd, longest, 3·5, 3rd 3·7, remainder shorter to the last, 6·7 in length of body. First soft ray 6 in body length, 5th–6th longest, 4·8 in body length, remainder graduated shorter, last ray depressed reaches caudal base. Edge of fin convex. A 1, 12, inserted below the base of the third dorsal ray. Rays slightly shorter than dorsal rays, edge of fin convex.

Pectoral 1·1 in head, reaches to above anal origin. Ventrals 1·3 in head, do not reach vent. Caudal lanceolate, 1·5 times head. Peduncle 1·7 times as long as deep.

Scales strongly ctenoid. Lateral series 30, l. tr. 9 (at shoulder). Head, and nape in advance of dorsal, naked.

Colour.—Olive-grey, lighter below. Several darkish blotches on upper

hind part of body, last at caudal base. Numerous small blotches on scale margins on upper part of body. A dusky patch on the opercle. A dark cruciform patch from below the eye to the maxilla, a smaller fainter oblique bar forwards anteriorly. Dorsal and anal with series of annular darker

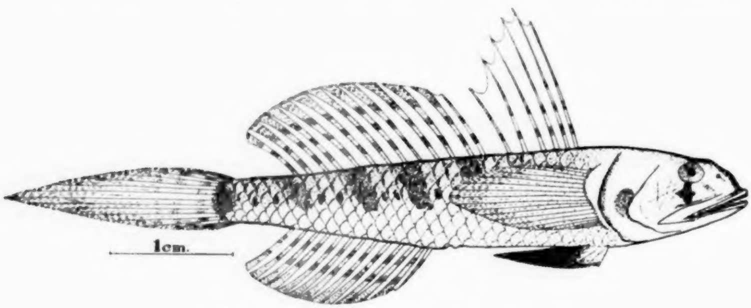

FIG. 1.—*Gobius keiensis* n. sp. (Type).

markings, a few similar on bases of caudal rays. Ventrals mostly dark. Pectorals light. Iris dark, top of head dusky.

Length.—60 mm.

Locality.—Mouth of the Great Kei River.

Type in the Albany Museum, Grahamstown, presented by R. Heathcote, Esq.

This fish might at first sight easily be mistaken for *Gobius acutipennis* C. & V., to which it is related by numerous features. *G. keiensis* is, however, very clearly differentiated by numerous characters. The shape of the head, the very much longer maxilla, the shorter dorsal spines, the shorter ventrals, more slender body, smaller scales and several other features are together more than sufficient to render the species distinct.

The type is a mature female with fully developed ripe ovaries.

I wish to express my gratitude to the Research Grant Board of South Africa (Carnegie Fund) for financial assistance.

ALBANY MUSEUM,
GRAHAMSTOWN,
September 1937.

POTTERY FROM THE SALISBURY DISTRICT, SOUTHERN RHODESIA.

I. The Topography of Echo Farm, Didcot Farm, and the Ruins on Didcot Farm, near Salisbury, Southern Rhodesia. By the Rev. Father Stapleton, S.J.

II. The Pottery from Echo Farm, Didcot Farm, and the Ruins on Didcot Farm, near Salisbury, Southern Rhodesia. By J. F. Schofield.

III. A Proposed Classification for the Pottery of Southern Rhodesia. By J. F. Schofield.

IV. Notes on Iron Implements from Echo Farm. By J. F. Schofield.

(With six Text-figures.)

(Read March 16, 1938.)

I. The Topography of Echo Farm, Didcot Farm, and the Ruins on Didcot Farm, near Salisbury, Southern Rhodesia.

Echo Farm is situated fourteen miles to the north-east of Salisbury. It forms part of the Borrowdale Estate, and lies to the south of the Chindamora Reserve, to which it practically adjoins. The Risumbe Stream flows through the farm to join the Umwindsi River.

The farm occupies a narrow valley which is flanked on the northern side by a continuous granite ridge of some height. On the southern side it is more open and is bounded by a line of granite kopjes. The valley, which extends for a mile or so above the farm, is cut in two by the Risumbe Stream.

Amongst the rocks of the ridge there are a number of shallow shelters, which have been used in the past and indeed are still used as graves in the usual Bantu style, being closed by carelessly built walls of loose stones. In the kopjes there are some good Bushman sites and the usual graves.

The pottery was collected by Mr. Holmes from both the ridge and the kopjes.

Didcot Farm lies some twenty miles from Salisbury along the Beatrice Road. The pottery which is described as being from this farm was collected from the surface, in a small shelter, by Mr. Samuels, jr.

Didcot Ruin stands on a low kopje overlooking a stream. It is small in extent, and is built in good masonry with rounded corners at the entrances. No decoration was noticed on any of the walls.

The pottery was collected from the surface in the interior of the Ruin, which is strewn with small shards.

II. The Pottery from Echo Farm, Didcot Farm, and the Ruins on Didcot Farm, near Salisbury, Southern Rhodesia.

Introduction.

The study of the Prehistoric Pottery Industries of South Africa is still so much in its infancy that the description and interpretation of any collection of pottery, of which the provenance is known, is sure to be a real addition to our knowledge of a subject which will, we hope, eventually shed not a little light on the obscurity in which the past history of our Native Peoples is at present enshrouded.

The literature which deals with the Pottery of Southern Rhodesia is very scanty, and the only works to which we can make reference are Maciver's Mediaeval Rhodesia (3), Caton-Thompson's Zimbabwe Culture (1), York Mason's "Penhalonga Ruins" (4), the writer's paper on "The Salisbury Commonage Sites" (5), and his "Report on the Pottery from the Mapungubwe Sites" (6).

A Description of the Pottery.

The pottery from the farms Echo and Didcot falls into the five following categories:—

(1) A coarse ware, finished to a buff or greenish buff matt surface, which includes the following types:—

(*a*) A Deep-bowl with an everted rim, which was decorated along the under edge with a band of comb marks (fig. **1**, 1).

(*b*) A Carinated-pot, the rim decorated on the outside with a slightly projecting band with rough diagonal comb marks (fig. **1**, 2 and fig. **3**, 1) and the carination emphasised by a line of comb marks.

(*c*) A Shouldered-pot, decorated round the rim with comb marks (fig. **1**, 3).

(2) A similar ware to the last, but bangle impressions as well as comb marks were used in decoration, and yellow, red, and graphite were employed as surface finishes. The following types are included:—

(*a*) Deep-bowls with rounded rims. These were decorated below the rim and on the inner surface of the bowl with a band of bangle

or comb marks. One piece (fig. **1**, 7) had the exterior finished to a brown burnish, but the remainder had red, graphite, or brindled surfaces (fig. **1**, 9 and 10 and fig. **3**, 3).

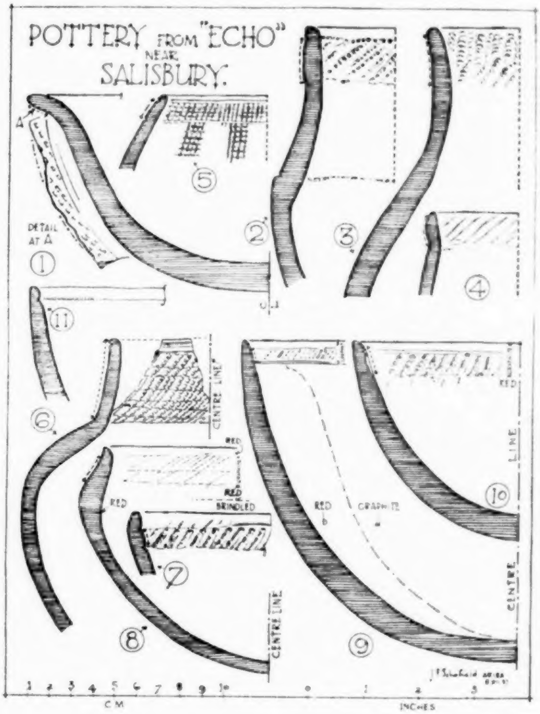

FIG. 1.

(*b*) A Deep-bowl, burnished with red and graphite, and decorated externally with a band of comb marks below the rim (fig. **1**, 8).

(*c*) A Pot with a contracted neck (fig. **1**, 6 and fig. **3**, 2). The neck was decorated with fine comb marks in diagonal lines, and with roughly incised lines running parallel to the rim. A fragment of a Shouldered-pot of the same kind was also taken, and two pieces of the neck of another similar pot which had been coloured red on the inside and had the outside finished to a light buff.

(*d*) A Pot of uncertain shape, of which the rim had a slightly projecting band with diagonal knife marks cut into it (fig. **1**, 4).

(*e*) A Pot, about 8 inches over the rim, which had directly below it an indented band of impressions, made with a fine wire bangle and traversed by horizontal lines.

(3) Wares finished to a grey or black matt or burnished surface, and which were decorated with incised bands round the shoulders. The only

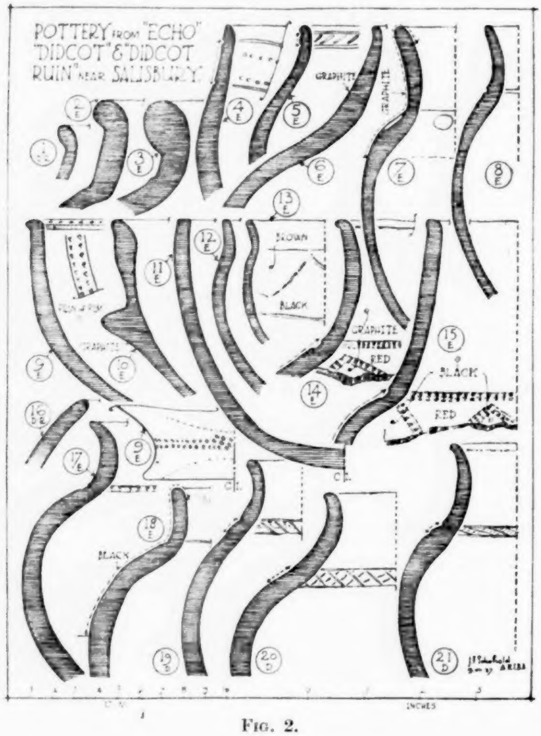

FIG. 2.

types recognised being Shouldered-pots and Short-necked pots (fig. **2**, 8, 19, 20, and 21 and fig. **3**, 4).

(4) A ware decorated with stylus impressions and also with lines or recessed bands made by dragging a rough-ended stick across the wet clay, into which it was pressed at intervals. Pieces were burnished with black or graphite, and also with red. Two pots were decorated with dimples (fig. **2**, 7), both singly and in pairs, apparently made by pressing the finger-tips into the wet clay below the junction of the neck with the body of the pot. The following types have been included in this category:—

(*a*) Deep-bowls, both with and without pedestals (fig. **2**, 9 and 11 and fig. **3**, 7).
(*b*) A Deep-bowl or lid with a horizontal ridge (fig. **2**, 10).
(*c*) Shouldered-bowls (fig. **2**, 12 and 13).
(*d*) Shouldered-pots (fig. **2**, 5, 6, and 14).
(*e*) Pots with short necks (fig. **2**, 1, 2, and 3 and fig. **3**, 6 and 9).

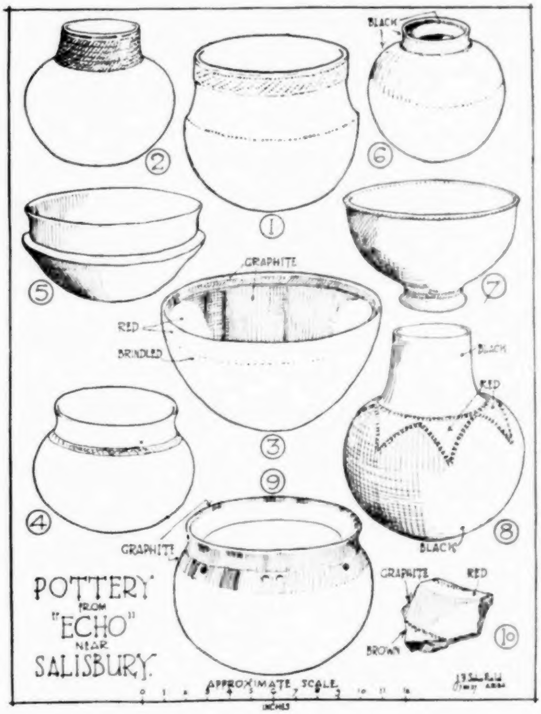

Fig. 3.

(*f*) A Pot with a tall contracted neck (fig. **2**, 15 and fig. **3**, 8).
(*g*) A Beaker (fig. **2**, 4).

(5) ***Miscellaneous.*** Several fragments of modern pottery are included under this heading, such as the small pot with the hole in its base, and the Spherical-pot (fig. **2**, 16), which is ubiquitous over the greater part of the Sub-Continent.

Discussion.

Category (1).—As all the material from these sites was taken from graves, or collected on the surface, where there was no trace of stratigraphy, it is fortunate that we have the evidence from the Salisbury Commonage sites available for its interpretation (5).

On Site No. 1 on the Commonage, pottery was found on all the three horizons, A, B, and C, in varying quantities. In horizon A decorated pottery was plentiful, and all the types which we have included in Category (2) were present, but were represented by very small fragments. Throughout horizon B the pottery became scarcer as the work proceeded. A fragment with a graphite burnish, which otherwise resembles fig. **1**, 5, was taken about the middle of the horizon, but very little was found at a lower level; the single piece from horizon C came therefore as a surprise, and indicates that a considerable period must have elapsed between the date at which it was deposited and that of the pottery found at higher levels. The pot itself was decorated round the rim with comb marks and resembles very closely those which we have included in this category, which we must therefore consider as being the earliest found on the three sites which we have under review.

The Carinated-pot (fig. **1**, 2) is clearly connected with the wares from the Limpopo sites, and more particularly with those from Bambandyanalo and Parma (6, pl. xxvii, 11), for at both of these places pots were found which had the carination emphasised by a line of comb marks. The decoration below the rim is also similar, but it finds its nearest affinities in pottery from Serowe and Gokomere, in both of which the decorated band was brought slightly forward, precisely as was done in our example.

The large bowl (fig. **1**, 1) has no close parallel of which we are aware, but both the kind of clay used, and the way in which the underside of the rim was decorated with a band of comb marks, makes it clear that it should be included in this category.

From the foregoing, we believe that it will be evident that the pottery of this category belongs to a widely spread tradition which includes Caton-Thompson's Class A from Zimbabwe, pottery from several sites from Bulawayo to Umtali, but chiefly from Gokomere, where it has been found in a great profusion and in a large variety of types and designs.

Category (2).—Horizon B, at Site 1, Salisbury Commonage, yielded a number of rim fragments of bowls which were decorated on the inside with comb marks or bangle impressions. These were all so small that it was impossible to form any idea of the size or shape of the vessels of which they had formed part. It is therefore of great interest to discover that they were similar to the Deep-bowls from Echo, and that we can assume

that they too belonged to bowls which were unusually deep in relation to their width, which varied from six to ten inches.

No sign of colour was found on any of the Salisbury Commonage fragments, which resembled very closely the piece illustrated on fig. **1**, 7. We must not assume from this that our polychrome bowls should be placed in a different category, for we know, from our finds at Mapungubwe, that polychrome pottery was strictly contemporary with the earliest types found there. It has been recognised for some time past that the polychrome wares of the Pedi, and other Sotho peoples now living to the south of the Limpopo, probably had their prototypes in Rhodesia, but this is the first time that such wares have been recorded, for although the bowls with interior decoration are not found amongst those peoples at the present time, the one illustrated on fig. **1**, 8 is both in its colouring and in its decoration so similar to Pedi wares that had its provenance not been so clearly established it would have been assigned to the Northern Transvaal.

The piece illustrated (fig. **1**, 5) seems to be nearer to the one belonging to Group 2 (*c*), horizon B, Site No. 1, Salisbury Commonage. It is probable that the decoration of both was made with a finely twisted wire bangle, and although the colouring of the first was a reddish brown, and that of the second was graphite, they are probably similar wares. A parallel may also be traced in a fragment from Malanga, one of the Limpopo Valley sites (6, pl. xxxiii, 24), and perhaps also in the pottery from Niekerk, illustrated (3, pl. xi, 9)..

The small pot with a constricted neck (fig. **1**, 6) indicates the origin of several fragments from horizon B, Salisbury Commonage, and the fact that two such shards from Echo are coloured red on the inside surface of the neck suggests that we have in them a parallel to the pottery which we have termed M_3c from Mapungubwe. The colouring is similar, and the fact that the more southern examples were decorated with herring-bone lines instead of diagonal comb marks does not dispel the impression that they all belong to a similar tradition.

The pot (fig. **1**, 4) had a projecting band decorated with knife-cuts round the rim in a manner reminiscent of a piece from horizon B, Salisbury Commonage, and also, in a lesser degree, of pottery from Aasvoelskop, near Johannesburg. It was coloured a deep red, and there is no doubt but that it should be included in this category.

Category (3).—It would have been quite impossible to disentangle this pottery from that of the succeeding category had it not been for our work at Mapungubwe, where vast numbers of shards (6, pl. xxi, 5), in every way similar to fig. **2**, 19, 20, and 21, were discovered. The fact that all of these last came from Didcot indicates that this pottery tradition was stronger there than at Echo, where only one piece (fig. **2**, 8) was taken.

The fact that only two types were found suggests that we are dealing with a partial survival only, and not with a fully-fledged industry such as existed at Mapungubwe.

The Short-necked Pot (fig. **2**, 18) may belong to either our Third or our Fourth Categories, or it may be a distant relative of that fine family of pots which were unearthed by Caton-Thompson at Dhlo-Dhlo. Its shape is suggestive of this, but the fact that its upper half was blackened makes our second alternative the more likely.

In much the same way the Ridged Bowl (fig. **2**, 10) may belong to this category, or it may be related to the Que-Que Pot, now in the Salisbury Museum, and to Caton-Thompson's ridged ware from Zimbabwe which she termed Class Bi. In any case it is probable that it served as a lid as well as a bowl, as did that curious example illustrated (6, pl. xxxi, 1) from Mapungubwe, for it is not at all improbable that both are variants of the same theme.

Category (4).—With our fourth category we are on much firmer ground, for we can definitely correlate it with Modern Shona Pottery, which seems to combine elements from Category (3) with those of the Roswi-Venda wares, and which appears to be diffused over a large area of Southern Rhodesia. This pottery sometimes takes the form of vases of quite exceptional shapes, from one of which the fragment illustrated in fig. **3**, 10 was probably derived.

The brown pottery, described by Caton-Thompson as Class C, is a variant of this ware, several examples of which were found on our sites. Amongst these we have fig. **2**, 2, and perhaps fig. **2**, 4 and 5. The commonest type is that of a large Spherical Pot, the neck is either short or absent, and the rim everted with a bold roll, whilst a little below it is a band of rough diagonal hatching or similar simple decorative motif.

As will be readily understood, such a widely spread tradition has developed many local variations, and amongst the pottery before us we may signalise the use of the wide recessed dragged line (fig. **2**, 14, 15, and 17), the use of point impressions as distinct from comb marks (fig. **2**, 9 and fig. **3**, 10), the use of graphite to burnish the upper half of a pot, the remainder being left a self colour matt (fig. **2**, 7), and on the same piece the dimple decorations of which we have had no previous acquaintance.

The Pedestal Bowl (fig. **2**, 9) is very similar to a bowl from Rusapi, in the Natal Government Museum, except that the rim of the latter is strongly everted and it is undecorated, having none of those point marks which are such a striking feature of our bowl. This bowl, together with that illustrated (fig. **1**, 11), seems to have been broken and then repaired with wax before they were used as grave goods, an example of thrift which we believe to be unusual in these low latitudes and amongst our native

population. In any case this practice makes it certain that fig. **1**, 11 belongs to this category, and not to the Second, to which the recessed roll on the inner surface of the rim would seem to relate it.

A number of rim sections are illustrated by York Mason (4, fig. 4), and by the writer (6, pls. xxxiv and xxxv), which show a similar treatment to some of ours, and more particularly to fig. **2**, 1, 2, 3, 12, and 13, while the coloured plate No. xxxiii of Mediaeval Rhodesia gives a good idea of the decoration of the more elaborate pieces.

Miscellaneous Pottery.—The small pot with the perforated base was probably a part of a primitive still, for the writer has seen a similar example which was in use quite recently in the Messina district of the Northern Transvaal. Pieces such as the Spherical Pot (fig. **2**, 16) have apparently been made as long as pottery has been made at all, and it is impossible to classify them except in the presence of stratigraphical evidence, which in this case is wholly lacking.

Distribution of the Pottery.—By far the most representative collection of pottery came from Echo, for examples of all our categories were found there with the doubtful exception of the Third. At Didcot, on the other hand, pottery of Categories (3) and (4) only occurred, while at Didcot Ruin all the pottery seems to belong to our Fourth Category.

Summary of Conclusions.

(1) The pottery which we have included in Category (1) undoubtedly belongs to Caton-Thompson's Class A, which we have shown elsewhere (6, p. 57) to be in all probability due to people of a Sotho culture. The date is doubtful, but it may, in Southern Rhodesia, be as early or even earlier than the fifteenth century.

(2) The pottery of Category (2) belongs to a related and, we believe as far as these sites go, to a later tradition in which polychrome decoration was used. As this pottery seems to have something in common with the pottery from Aasvoelskop, and also with the pottery of the Pedi and related peoples, we suggest that it too is of Sotho origin, but that it is derived from a different branch from that which made the pottery of our First Category.

(3) The pottery of Category (3) came almost entirely from Didcot, and while it shows strong affinities to the Class M_1 wares from Mapungubwe, which we have attributed to the Shona on that site, we have not sufficient evidence to make such a statement regarding Didcot.

(4) The pottery of Category (4) represents a synthesis between pottery of our Third Category and that of the Roswi-Venda cultural group of peoples.

III. A Proposed Classification for the Pottery of Southern Rhodesia.

From the foregoing it will have been seen that we have as yet no comprehensive classification for the various pottery traditions which have been discovered in Southern Rhodesia, and we therefore take this opportunity to suggest the use of the following symbols:—

Class R_1.—Caton-Thompson's Class A from Zimbabwe and Dhlo-Dhlo, Salisbury Commonage Pottery from Horizon C, Site No. 1. Echo Pottery, Category (1) (fig. **1,** 2 and 3 and fig. **3,** 1). Pottery from Maonza Cave, Umtali, now in the Museum of the Medical School, Witwatersrand University. Pottery from Madiliyanga Rock-shelter and Gokomere.

The reasons for ascribing this pottery to people of the Sotho Cultural Group have been discussed elsewhere (6, p. 57); all the evidence we have at our disposal tends to show that these people crossed the Limpopo on their southward journey in a series of waves, somewhere about the middle of the fifteenth century. This ware may therefore have a Mediaeval date in Rhodesia; for the Dhlo-Dhlo fragment is certainly earlier than 1700, but, on the other hand, the beads from Gokomere appear to date the end of the occupation of that site to the middle of the eighteenth century.

Class R_1a.—Includes the pottery from Horizons A and B of Site No. 1, Salisbury Commonage, and that of Category (2) from Echo (fig. **1,** 4, 6, 7, 8, 9, and 10 and fig. **3,** 2 and 3).

This pottery belongs to the polychrome branch of the Sotho wares, and resembles that of the Pedi and related peoples.

On the Commonage site it is later than Class R_1, but we have no means by which we can date it more definitely.

It must be noted that both Class R_1 and Class R_1a have been found in conjunction with late Wilton material.

Class R_1b.—This class includes the bangle decorated wares from Niekerk and Penhalonga; it may also be related to our Group (2) *c* from Salisbury Commonage and a rim from Echo, fig. **1,** 5.

We have at present no evidence regarding the dating of this pottery.

Class R_2.—This class includes Class M_1 from Mapungubwe (fig. **5,** 1, 2, 4, 5, 6, 8, and 10), the grey pottery of Caton-Thompson's Class B from Zimbabwe (fig. **5,** 3 and 7), and Category (3) wares from Didcot (fig. **2,** 19, 20, and 21).

It is characterised by the use of blackish clay finished with a honey-coloured, grey, or black burnish. The shapes were often elegant and the decorations were always cut on the wet clay.

No certain examples of fusion between this class and the preceeding classes have been noted.

We have attributed this ware to the Shona, and it may be dated as being subsequent to 1500 (6, p. 41).

Class R_2a.—The Ridged pottery from Zimbabwe, Caton-Thompson's Class Bi, of which the Que-Que Pot is the best example. It appears to be strictly contemporary with Class R_2.

Class R_2b.—Pottery similar to Class R_2, but in which the field of the decoration is covered with stippling. Class M_3f from Mapungubwe is characteristic of this ware. The fragments shown on pl. xxxiv, 2 and pl. xxxv, 26 (3) seem to belong to this class.

Class R_2c.—Undecorated spherical and short-necked pots with a brindled burnish, from Dhlo-Dhlo, and dated as later than 1700 on that site (pl. xliii (1)).

Class R_3.—The pottery of the Roswi-Venda peoples. The distinguishing feature of this ware is the employment of engraved lines in conjunction with polychromic decoration. It is probable that the Changamire who harried the Portuguese settlements on the Zambesi in 1698 was the moving spirit in the Roswi-Venda conquest of Southern Rhodesia, and that these people invaded the Transvaal about 1750. This class of pottery has been found at Dhlo-Dhlo, where its date is certainly later than 1700, Zimbabwe, Nanatali, Khami, Dzata, and many other places (fig. **6,** 4, 5, 6, and 7).

Some of the decorated pieces of this pottery were included by Caton-Thompson in her Class D.

Class R_3a.—This class includes our Category (4), elements from Caton-Thompson's Classes Bii and C, and may be regarded as representing a fusion between our Classes R_2 and R_3, and as forming the basis for the modern native pottery over a large part of Mashonaland (fig. **2,** 2, 3, 4, 5, 6, 7, 9, 11, 12, 13, 14, 15, 17, and 18, fig. **3,** 8, 9, and 10, and fig. **6,** 1, 2, and 3).

IV. Notes on Iron Implements from Echo Farm.

Three iron implements were found on Echo—an assegai head, a leaf-shaped hoe, and a triangular hoe.

The assegai head is tanged and measures 11·4 cm. in length by 2·0 cm.

in width. The blade has the usual longitudinal contraflexion found in African weapons (fig. **4**, 1).

The leaf-shaped hoe is tanged and measures 8·8 cm. in width by 27·4 cm. in length, and was originally somewhat longer. The blade is curved longitudinally and shows similar contraflexion to that of the assegai head.

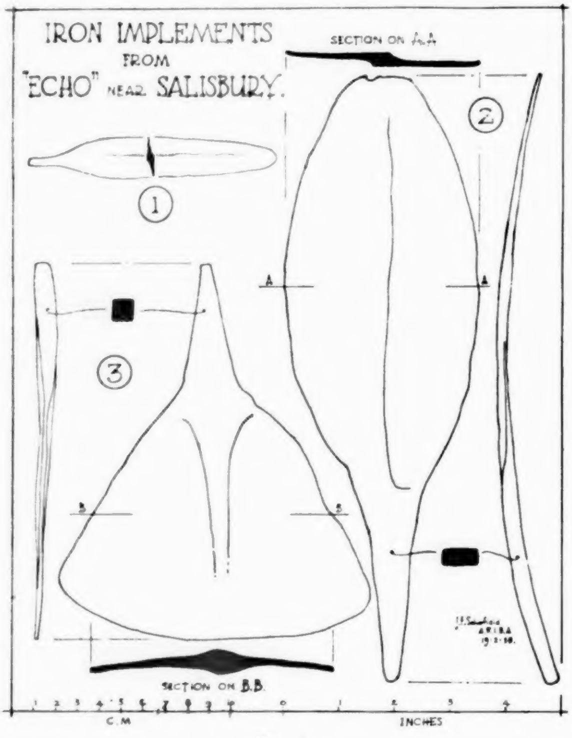

FIG. 4.

We believe that this feature, which is common enough in spears and knives, is unusual in a hoe (fig. **4**, 2).

The triangular hoe is tanged and measures 14·2 cm. in width by 17·0 cm. in length, the blade has a midrib on both sides and resembles the one from Zimbabwe illustrated on pl. xxxi, 14 (3) (fig. **4**, 3).

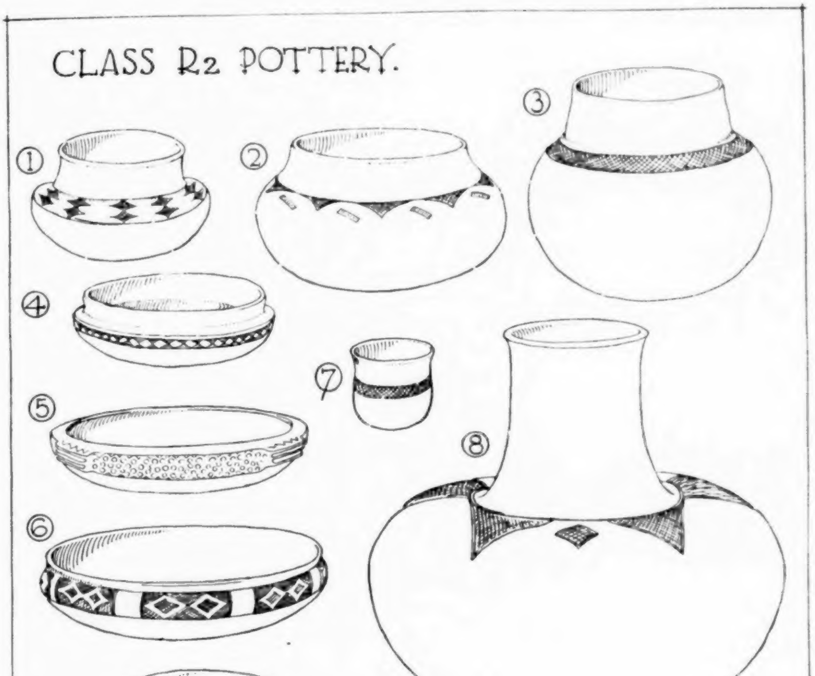

FIG. 5.

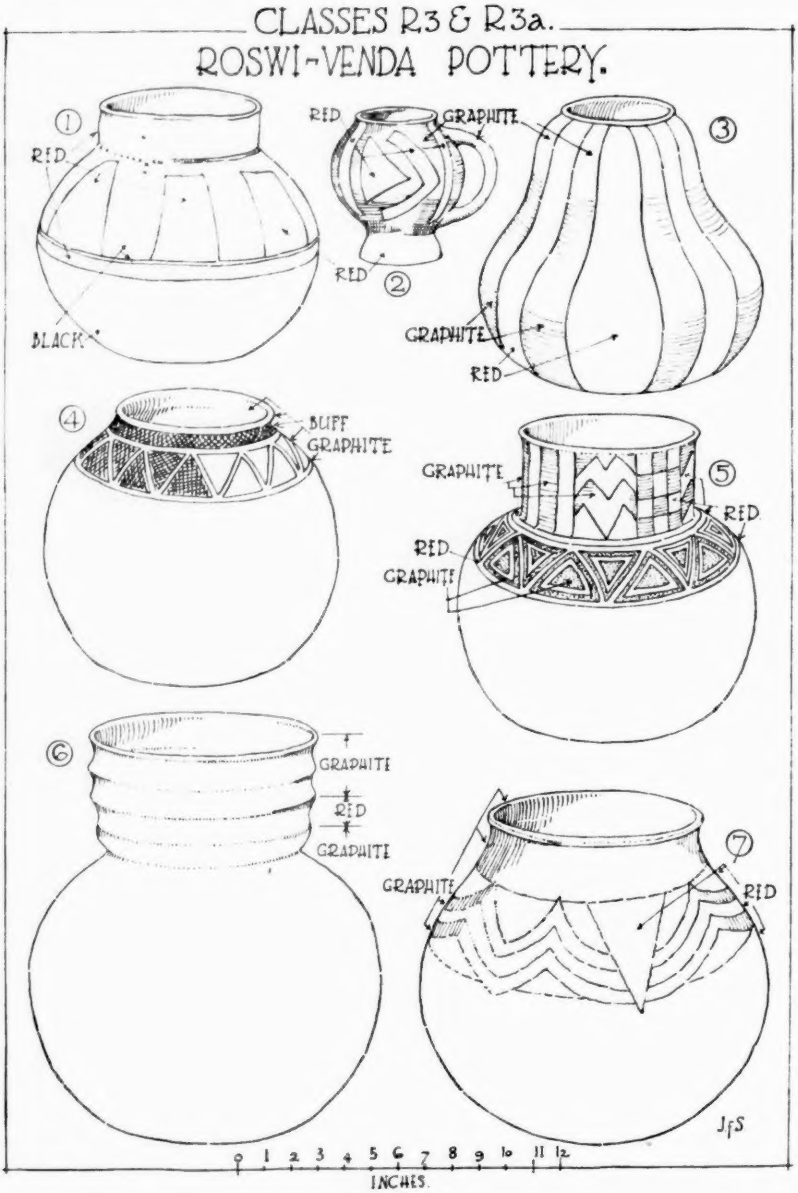
CLASSES R3 & R3a.
ROSWI-VENDA POTTERY.
1
RED
BLACK
2
RED
GRAPHITE
RED
3
GRAPHITE
RED
4
BUFF
GRAPHITE
5
GRAPHITE
RED
RED
GRAPHITE
6
GRAPHITE
RED
GRAPHITE
7
GRAPHITE
RED
JFS
0 1 2 3 4 5 6 7 8 9 10 11 12
INCHES.

Fig. 6.

DESCRIPTION OF TEXT-FIGURES.

Fig. 1.

(1) A Deep-bowl, 8½ inches over the rim and 3½ inches in height. In a coarse grey clay finished to a light brown matt surface. The rim was everted and decorated on its lower aspect with a band of diagonal comb marks.

From Echo Farm. Class R_1.

(2) A Carinated Pot, 7 inches over the rim and about 6¾ inches in height. In a coarse grey clay finished to a buff matt surface. The rim was rounded, and directly below it a slightly projecting band was formed and decorated with diagonal comb marks below a line of similar impressions. The neck joined the body with a distinct ridge which was emphasised with comb marks. All the decoration was done in a very rough manner.

From Echo Farm. Class R_1.

(3) Fragment of a large Shouldered-pot, about 12½ inches over the rim. In a coarse grey clay finished to a greenish buff matt surface. The rim was rounded, and the neck, just below the rim, was decorated with comb marks or bead impressions.

From Echo Farm. Class R_1.

(4) A rim fragment of a pot 7 inches in diameter. In a dark grey coarse clay finished to a reddish matt surface. The rim was rounded, and directly below it a slightly projecting band was formed and decorated with diagonal knife-marks, cut on the wet clay.

From Echo Farm. Class R_1a.

(5) Rim of a large pot, about 8 inches over the rim. In a fine grey clay burnished to a reddish brown. The rim was rounded, and below it was a band of impressions made with a fine wire bangle, and traversed by horizontal lines. From the band small cantons formed with a cross-hatching of bangle impressions ran down towards the body of the pot at intervals of about 1 inch.

From Echo Farm. Class R_1b.

(6) A pot with a short contracted neck, 3½ inches over the rim and about 6½ inches in height. The clay was grey and fine and finished with a brown matt surface. The rim was rounded and directly below it were two lines, below these the neck was covered with comb marks in diagonal lines which were traversed by six horizontal lines.

From Echo Farm. Class R_1a.

(7) Rim of a bowl, about 9 inches in diameter, in a coarse grey clay, the inner surface was finished to a brown matt, and the exterior with a brindled burnish. The rim was rounded, and directly below it on the inner surface of the bowl was a recessed band of diagonal impressions made with a bangle of twisted wire on which there was a distance bead.

From Echo Farm. Class R_1a.

(8) A Shouldered-bowl, 6 inches over the rim by 4 inches in height. In a gritty grey clay, with the surface of the interior and of the upper part of the exterior burnished red. The lower part of the exterior surface had a brindled burnish, and the decorated band a graphite finish. The rim was rounded, and below it was a band formed with three horizontal lines of comb marks with irregular diagonal comb lines between the first and the second and triangles between the second and the third.

From Echo Farm. Perhaps Class R_1a.

(9) A Deep-bowl, 10 inches over the rim and 5¾ inches in height. In a coarse grey clay. The rim was tapered and rounded, and below it on the interior was a band of shallow diagonal comb marks. This band, the rim, and a large shield-shaped section of the

interior were burnished with graphite, the remainder of the interior was burnished red, and the exterior was finished to a brindled matt surface.

From Echo Farm. Class R_1a.

(10) A Deep-bowl, 6 inches over the rim and 3½ inches in height. In a coarse grey clay. The rim was rounded, and below it on the interior was a band of bead-string or bangle impressions. This band and the rim were burnished with graphite, the remainder of the interior was finished to a red matt, and the exterior to a brindled matt surface.

From Echo Farm. Class R_1a.

(11) A Deep-bowl, 10 inches over the rim and 5½ inches in height. In a gritty grey clay, finished to a black matt surface. The rim is square to the outside and finished internally with a recessed roll. This bowl appears to have been repaired with wax before it was buried.

From Echo Farm. The class is uncertain, probably R_3a.

Fig. 2.

(1) A fragment of the rim of a pot, about 8 inches in diameter. In a fine dark grey clay finished to a sepia matt surface. The rim was rounded, everted, and slightly rolled.

From Didcot Ruin. Probably Class R_3 or R_3a.

(2) A fragment of the neck of a large pot, about 11 inches over the rim. In a gritty reddish clay, finished to a light red matt surface. The rim was rounded and finished with a heavy roll.

From Echo Farm. Class R_3a.

(3) A rim fragment of a pot with a short neck, about 12 inches over the rim. In a gritty grey clay, burnt to a light red at the surface which had a brindled matt finish.

From Echo Farm. Class R_3a.

(4) A Beaker, 5 inches over the rim by about the same in height. In a fine buff clay with a brindled matt surface. The rim was rounded, and the neck, which tapered inwards, was decorated with a double row of small round point marks between two roughly drawn lines; all were made on the wet clay.

From Echo Farm. Class R_3a.

(5) A Shouldered-pot, 5 inches over the rim and 6 inches in diameter. In a coarse buff clay burnt to a smooth reddish brindled surface. The rim was rounded, and below it was a band of bold hatching between two roughly drawn lines; all were made on the wet clay.

From Echo Farm. Class R_3a.

(6) Fragment of a large Shouldered-pot, 9 inches over the rim. In a coarse buff clay, finished to a buff matt surface, burnished with graphite round the neck. The rim was rounded and slightly rolled.

From Echo Farm. Class R_3a.

(7) A pot with a short everted neck, 8 inches over the rim and 7¼ inches in height. In a black gritty clay burnt to a red matt surface. The neck, the inside of the rim, and the upper part of the body were burnished with graphite. The rim was rounded, the neck joined the body with a slightly marked line, directly below the junction dimple impressions were made, ½ inch in diameter, both singly and in pairs.

From Echo Farm. Class R_3a.

(8) A Shouldered-pot, 8½ inches over the rim, in a coarse black clay with a burnished black surface. The rim was slightly flattened, and the shoulder was marked with a deep line cut on the wet clay.

From Echo Farm. Probably Class R_2.

(9) A Pedestal Bowl, 7½ inches over the rim and 4⅝ inches in height. In a blackish gritty clay with a black matt finish on the outside and a graphite burnish on the inside. The rim was rounded and flattened with a prominent projection externally, and decorated with triangular point marks on its upper aspect. A double line of slotted impressions were used to decorate the neck of the pedestal, all being made on the wet clay. The bowl had been broken and repaired with wax before it was buried.

From Echo Farm. Class R_3a.

(10) A Hemispherical Ridged Bowl or Lid, 7½ inches over the rim. In a coarse grey clay with a graphite burnish. The rim is thickened on the inside and rounded and slightly everted. The neck is swelled and terminates in a prominent rounded ridge.

From Echo Farm. Class R_2a or R_3.

(11) A Deep-bowl, 6 inches over the rim and 4½ inches in height. In a gritty greyish clay, finished with a brindled burnish. The rim was cut square.

From Echo Farm. Probably Class R_3a.

(12) A Shouldered-bowl, 5 inches over the rim by 3⅝ inches in height. In a gritty greyish clay finished to a black matt surface. The rim was flattened and the neck slightly everted.

From Echo Farm. Class R_3a.

(13) A Shouldered-bowl, 4½ inches over the rim. In a fine blackish clay. The rim was flattened and the neck was everted and finished with a brown burnish. The shoulder had a band of triangles roughly incised on the wet clay, and burnished alternately black and brown. Below this band the surface was burnished black.

From Echo Farm. Class R_3a.

(14) A Shouldered-pot, 4¼ inches over the rim. In a gritty brown clay, the interior of the neck was burnished brown, and the exterior finished with graphite. The rim was rounded and rolled, and the neck everted. The shoulder was emphasised by a dragged line, and similar lines contained the alternate red and graphite triangles with which the upper part of the body was decorated. All was done on the wet clay.

From Echo Farm. Class R_3a.

(15) A Pot with a tall contracted neck, 3½ inches over the rim. In a fine brown clay. The interior of the neck was smoothed and the exterior was burnished black. Otherwise this pot is similar to (14), except that black was used instead of graphite as a surface finish.

From Echo Farm. Class R_3a.

(16) A Spherical-pot, 7 inches over the rim. In a gritty black clay with a brown burnish externally, the interior surface being smoothed. The rim was rounded.

From Didcot Ruin. Class indefinite.

(17) A Shouldered-pot, 3¾ inches over the rim and about 5⅞ inches high. In a gritty brown clay, burnished black externally. The rim was rounded and the neck everted. The shoulder was decorated with a dragged line made on the wet clay.

From Echo Farm. Class R_3a.

(18) A Pot with a short neck, 3¼ inches over the rim and about 6¼ inches in height. The clay was grey and gritty with a brown matt surface, which was burnished black on the neck, the upper part of the body, and on the interior of the rim. The rim was rounded and the neck slightly everted. The neck-body junction was covered with a line which was cut on the wet clay.

From Echo Farm. Probably Class R_3a.

(19) A Shouldered-pot, 5½ inches over the rim and 6½ inches in height. The clay was blackish and gritty, and finished to a grey matt surface externally. The rim was rounded

and the neck everted. The shoulder was decorated with a band of diagonal hatching over a dragged line.

From Didcot Farm. Class R_2 or R_3a.

(20) A Shouldered-pot, 5¾ inches over the rim. In a gritty grey clay finished to a grey matt surface. The rim was rounded and slightly everted. The shoulder was decorated with a band of diagonal cross-hatching, roughly cut on the wet clay.

From Didcot Farm. Class R_2.

(21) A Shouldered-pot, 5½ inches over the rim and about 6½ inches in height. The clay was grey and gritty and finished with a burnished black surface externally. The rim was rounded and everted, and the shoulder was decorated with a narrow band of diagonal cross-hatching which was scratched on the wet clay.

From Didcot Farm. Class R_2.

FIG. 3.

(1) See Text-figure **1**, 3.
(2) ,, ,, ,, **1**, 6.
(3) ,, ,, ,, **1**, 9.
(4) ,, ,, ,, **2**, 20.
(5) See Text-figure **2**, 10.
(6) ,, ,, ,, **2**, 18.
(7) ,, ,, ,, **2**, 9.
(8) ,, ,, ,, **2**, 15.
(9) See Text-figure **2**, 7.

(10) A fragment, probably from a vase of unusual shape. In a gritty greyish clay. A band of red burnish ran round the edge of the upper surface, and was separated by a concentric line of point marks from the more central portion which was burnished brown. The surface below the edge was burnished with graphite, and was likewise separated by a line of point marks from a brown burnished area.

From Echo Farm. Class R_3a.

FIG. 5.

(1) A Bowl with a contracted neck. 4 inches over the rim, 5½ inches in diameter, and 3 inches in height. In a fine grey clay, burnished black both inside and outside. The rim was rounded and everted, the neck was canted inwards, and the shoulder was decorated with pairs of hatched lozenges, coupled vertically, at 1¾-inch centres. (6, pl. xviii, 14.)

From Mapungubwe. Class R_2.

(2) A Shouldered-bowl. 6½ inches over the rim, 9 inches in diameter, and 5 inches in height. In a fine black clay, with a black burnish externally and to the interior of the rim, which was rounded and slightly flattened. The shoulder was decorated with diagonally cross-hatched triangles, interspaced with cross-hatched rectangles, all of which were cut on the wet clay in a bold style. (6, pl. xix, 7.)

From Mapungubwe. Class R_2.

(3) A Pot with a contracted neck. 6 inches over the rim. In a light reddish-brown matt ware. The rim was rounded and the shoulder decorated with a band of diagonal cross-hatching.

From Zimbabwe. Class R_2.

(4) A Shallow Bowl. About 9 inches over the rim and 10 inches in diameter. In a fine dark grey clay, both the inside and the outside were finished with a poor black burnish. The rim was rounded and everted and joined to the body of the bowl with a well-marked set-off. The decoration was cut on the wet clay in a poor style. (6, pl. xvii, 7.)

From Mapungubwe. Class R_2.

(5) A Shallow Bowl. 8¾ inches in diameter and 2⅞ inches in height. In a red clay, finished to a fine Indian-red matt surface. The rim was bevelled to the outside, and

divided by three projecting lugs, each with two deep and rounded grooves on its face, and a lightly scratched chevron on the surface of the bevel. The panels between the lugs were decorated with impressions made with a rounded stylus on the wet clay. A festooned effect was produced by making the panels narrower at the ends than in the middle. (6, pls. C, *b* and xxii, 3.)

From Grave 11, Mapungubwe. Probably Class R_2.

(6) A Shallow Bowl. 10 inches over the rim and 11 inches in diameter. In a fine grey clay beautifully burnished both inside and outside. The rim was rounded and slightly everted. The decoration was cut on the wet clay with an unsurpassed precision.

From Mapungubwe. Class R_2. (6, pl. xvii, 1.)

(7) A Small Beaker. 3⅛ inches over the rim. In a smooth grey-brown ware. The rim was flattened and slightly everted, and the body was decorated with a band of diagonal cross-hatching.

From Zimbabwe. Class R_2.

(8) A Tall-necked Pot. 5¼ inches over the rim, 15 inches in diameter, and 14¼ inches in height. In a grey clay with a brownish-grey burnish on the outside. The rim was rounded, everted, and slightly undercut. The neck runs outward to the body and the junction was decorated with four large cross-hatched triangles and a cross-hatched lozenge; all were cut in a very good style on the wet clay. (6, pl. xx, 4.)

From Mapungubwe. Class R_2.

(9) A Tall-necked Pot. This pot is illustrated in Hall and Neal's Ancient Ruins of Rhodesia, pl. 4, and is described as being a

> "Jar of pottery sixteen inches in height, circumference [*sic* diameter] at widest part twelve inches. The make of the jar is of the best Zimbabwe workmanship yet found in the country." *Ibid.*, p. 313.

From M'Telegwa Ruins. Class R_2.

(10) A Shouldered-pot. 9 inches over the rim, 13½ inches in diameter, and about 12 inches in height. In a fine grey clay, the inside of the neck was finished matt, and the outside had a grey burnish. The rim was rounded, everted, and undercut. The shoulder was decorated with a band of diagonally hatched triangles separated by plain fillets. The work was cut on the wet clay in a very fine style. (6, pl. xix, 4.)

From Mapungubwe. Class R_2.

FIG. 6.

(1) A Pot with a short vertical neck. 6½ inches over the rim, 10½ inches in diameter, and 9½ inches in height. The clay was reddish and gritty, and the whole of the exterior surface and the interior of the neck were burnished. The rim was rounded and rolled, and the neck slightly swelled. The junction between the neck and the body was covered in part by a narrow hatched band and in part by a line of circular point marks. The body has a central band, the upper part of which is black and the lower red. Above this band is a line of five large irregular trapezoids and one triangle, all of which are red on a black field. The lower part of the body was coloured black and the neck red. All the lines were cut on the wet clay.

From Mphephu's Kraal, near Louis Trichard. Class R_3a.

(2) A Cup. 3¼ inches over the rim, 5 inches in diameter, and 5 inches in height. In a reddish gritty clay with a red and graphite burnished surface, the respective areas of which were separated by lines cut on the wet clay. The rim has a small roll, the base is conoidal and hollow, and the handle is circular on section.

From Mphephu's Kraal, near Louis Trichard. Class R_3a.

(3) A Gourd-shaped Pot. 4 inches over the rim, 10½ inches in both diameter and height. The rim was rolled and the surface burnished with alternate strips of graphite and deep red, separated by lines which were cut on the wet clay.

From Mphephu's Kraal, near Louis Trichard. Class R_3a.

(4) A reconstruction based on the fragments of a large Spherical Pot, in a light buff clay. The rim was finished with a roll, and directly below it was a band of diagonal cross-hatching coloured buff. Below the band were large triangular panels of diagonal cross-hatching which were coloured red. These panels were separated from each other and from the cross-hatched band by plain surfaces or bands, burnished with graphite. The roll and the interior of the neck, down to the level of the lower edge of the cross-hatched band, were similarly burnished, the remainder of the interior was finished buff. All the decoration was cut on the wet clay.

From Dzata. Class R_3.

(5) A Pot with a short vertical neck. This is a conjectural reconstruction from fragments. Lines were engraved on the burnt pot.

From Khami. Class R_3.

(6) A Pot with a short flared neck. 8 inches over the rim. In a gritty black clay burnt red at the surface. The neck was divided into four horizontal divisions, of these the upper three were shallow flutes. The lowest division was coloured red and the remainder of the neck was burnished with graphite.

From Khami. Similar pots have been found at Niekerk. Class R_3.

(7) Conjectural restoration of a Shouldered Pot from fragments found at Maryland, near Messina, Northern Transvaal. (6, pl. xxxiv, 20 and 21.) About 8 inches over the rim and 13 inches in diameter. The rim was rolled, everted, and undercut. The neck was burnished with graphite. Round the shoulder there was a wide band formed with curved chevrons alternately red and graphite, and at least one large triangle which was burnished red. All the lines of the decoration were engraved on the pot after it had been burnt.

Class R_3.

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A PRELIMINARY STUDY OF THE PREHISTORIC BEADS OF THE NORTHERN TRANSVAAL AND NATAL.

By J. F. Schofield, A.R.I.B.A.

(Read April 20, 1938.)

Introduction.

The writer must first of all acknowledge his indebtedness to Beck for his pioneer work, for it is not too much to say that this work had never been undertaken but for the "Classification and Nomenclature of Beads and Pendants," the description of the Zimbabwe beads contained in Appendix I of "Zimbabwe Culture," and lastly his contribution to "Mapungubwe," to which Part I of this paper must be considered as supplementary.

The views which we have expressed are those of a field worker on the Mapungubwe site, and have not been modified in any important detail since reading Beck's work. That two independent investigators should have arrived at almost identical conclusions is a fact of some note; indeed, the only divergence of any consequence concerns the reported presence of Indian-red beads at the "Bowl." As the point is of some importance, and as the writer personally supervised the sieving out of all the beads from that place, he feels that he is justified in stating that they did not occur there.

To facilitate reference to Beck's work, his terminology is used where possible, and the symbols he uses are given in brackets.

Bead dimensions are always given in millimetres; the first figure indicates the diameter of the bead, and the second its length, measured on a line parallel to the bore.

PART I.

The Beads of Mapungubwe.

During the months of May, June, and July 1934, the writer was engaged with Mr. Neville-Jones, F.R.A.I., in an archaeological exploration of the Mapungubwe Site in the north-western Transvaal, under the auspices of the Archaeological Committee of the University of Pretoria (7).

The site lies about a mile south-east from the confluence of the Shashi and the Limpopo Rivers, and takes its name from a cave-sandstone kopje, which is isolated from the surrounding grass-lands by sheer krantzes, and formed an ideal stronghold for a primitive community. The kopje runs from north-west to south-east, its width is about 60 yards, and its greatest length is about 300 yards.

The top of the kopje is at present covered with a capping of soil which weighs at least 20,000 tons, all of which was carried up the precipitous krantzes from the neighbouring valleys in prehistoric times. Vast quantities of this occupational material have been swept from the hilltop, and at present form a talus, which spreads beneath the krantzes, and covers many acres of the surrounding country, which everywhere shows unmistakable traces of having at one time supported a large population.

About a mile due south from Mapungubwe there is an open tract of veld covered with midden material, which in places has a depth of 20 feet or more; this site has been named Bambandyanalo, from a neighbouring kopje.

In almost any part of this area, careful sieving will be rewarded with a few beads, but in four places they were discovered in quantities, and had other marked peculiarities which may be summarised as follows:—

The Bowl (J).

This is a hollow in the north-eastern edge of the kopje, and here we were fortunate to discover a pit, 6 feet wide by 8 feet deep, which had been weathered in the living rock. When the work of clearing this out was put in hand, we found that the upper 4 feet of the infilling consisted of sterile river sand. Below this we came on occupational material, and realising that this must have been deposited by the early inhabitants of the hill, we proceeded to sieve it most carefully.

As a result we obtained a large number of seed beads in a brilliant state of preservation, with the exception of a few of the black beads which were slightly corroded. All of the beads belonged to five types:

Deep blue,	oblate,	transparent,	1×2–$2{\cdot}5$ mm.
Pale blue,	,,	translucent,	,,
Yellow,	,,	,,	,,
Orange,	,,	,,	,,
Black,	,,	opaque,	,,

The black, pale blue, and the yellow were found in about equal quantities, the orange and the deep blue, in only half the numbers of the other colours. Beck has noted the occurrence of a single bead of colourless glass.

It is a remarkable fact that shell beads, which elsewhere were ubiquitous, were not found in the Bowl.

Discussion.

The importance of this collection of beads lies in the fact that they were a bed-rock find, that they were sealed by an artificial deposit of sterile sand, and that they were undoubtedly used by the early inhabitants of the kopje.

These beads resemble the bed-rock beads from Zimbabwe very closely, and not only is this the case with the types that were present, but also in the absence of the Indian-red and shell beads. The former was exceedingly scarce at Zimbabwe and the latter was not found at all in the lowest levels, this is all the more remarkable since both were found in great numbers everywhere else at Mapungubwe.

It is interesting to find that, according to Beck, these black beads resemble those from the Mauch and Chibvumani (Hubvumi?) sites, rather than those from the Acropolis at Zimbabwe. We have always regarded the age of the beads from this last site to have been exaggerated, not only from the types of beads found, which included the *Maḍi* and the Indian-red-on-green, but also from the fact that the sealing of the midden was consequent on the building of the Great West Wall of the Acropolis, and which, judging by the survival of the timber lintels of the entrance until A.D. 1914, cannot be of any great age.

The only one of these beads which appears to be current at the present time is the black, which the Venda regard as a great rarity, under the name of *Sodzi*.

Mr. W. G. Barnard of Sekukuniland has informed the writer that the Pedi recognise these beads as having been worn by the Kwena and the Shukudo peoples, who *bina*, as they term it, the crocodile and the rhinoceros respectively. These people are also called the Barokas by the Pedi, meaning the people from the north. From this it would appear that they belonged to a wave of the Sotho invasion, which was subsequent to that which carried the ancestors of the Pedi to the south of the Limpopo.

The Mapungubwe Grave Area (K).

This area occupies the centre of the northern half of the kopje. It is about a quarter of an acre in extent, and beads form an appreciable volume of the soil, which has an average depth of about three feet. Indeed the quantity of beads to be recovered depends entirely on the patience of the collector.

These beads may be classified as follows:—

Black, opaque small oblates similar to those from the Bowl.

Black, opaque larger oblates, measuring up to 4×3 mm.

Black, opaque cylinders of cane glass, about 2 mm. in diameter, and of very irregular length.

Yellow, opaque and translucent oblates; the sizes vary between 2×1 mm. and 3×2 mm. The colour varies from a greyish yellow to an orange or brown.

Pale blue, translucent oblates, similar in size to the yellows and in colour to those from the Bowl.

Deep blue, transparent cylinders of cane glass, about 1 mm. in diameter and of very irregular length.

Green, translucent oblates, similar to the pale blue.

Indian-red, opaque cylinders of cane glass, similar in size to the black cylinders.

With the exception of the small oblates, and a few of the cylinders, all the black beads and a number of the pale blues and the greens are very heavily corroded, while the yellows show a certain amount of surface change; the Indian-reds and the deep blues are in a much better condition.

Discussion.

The small black oblates are similar to those from the Bowl and therefore to the *Sodzi* of the Venda Canon.

The Indian-red cylinders and the black cylinders are respectively similar to the *Mukuvhibvu* and the *Tshinovhe* of the Venda.

The deep blues illustrate very clearly the important part which was played by fashion or individual preference, for these beads were found in one grave only, that of a little girl, into whose hair they had been threaded.

Beck remarks that the heavy corrosion, which we have already noticed, is one of the features in which the beads from Mapungubwe differ from those of Zimbabwe. We agree with Beck in putting this corrosion down to the action on the beads of the products of decomposition, for we have noted that it is almost absent from those beads which were buried in sterile soil. It is also evident that different kinds of glass have been affected in varying degrees, the Indian-reds, for example, being almost immune. This lends colour to Beck's suggestion that some of the large cylinders may have been made by remelting powdered glass beads, for in some of the examples the layers of glass of which they were formed are markedly different, for while some have been completely changed, others have remained intact (7, p. 112).

As all the burials in this Grave Area were made in occupational material, it must follow that all these beads were deposited during a late period in

the history of Mapungubwe; but since all of them formed part of grave furniture, it is probable that some at least were heirlooms, and belonged to an earlier generation than that of the actual interments. We suggest that the small black oblates and some of the other oblates belong to this category. A relatively late date for these beads, in comparison with those from the Bowl, is also indicated by the presence among them of two additional types of beads from the Venda Canon.

Trench JS 2a (B). *Burnt Hut Floor.*

This trench was driven south-west from the rough retaining walls and hut emplacements which lie in front of the western ascent, right out to the limits of the terraced area, which surrounds the base of the hill. During the progress of these excavations it was found that Wall No. 4 was in part built over the remains of a hut which had been burnt down; in clearing away the debris a great hoard of more than 3000 ostrich egg-shell beads came to light, and also several hundreds of well-preserved and quite uncorroded glass beads, many of which had been partly fused. All these beads were confined to four varieties of small irregular cylinders of cane glass, viz.:—

Black, opaque cylinders, as described above and similar to the *Tshinovhe* of the Venda.

Indian-red, opaque cylinders, as before and similar to the *Mukurhibeu* of the Venda.

Pale blue, translucent cylinders, similar to the *Maḓi* of the Venda, otherwise as the last.

Lemon-yellow, translucent cylinders, similar to the *Mushosho* of the Venda, otherwise as the last.

In numbers the black beads were twice as plentiful as the Indian-red and the pale blue, which were found in approximately equal quantities, while the lemon-yellow beads were represented by a few specimens only.

Discussion.

We judge from its position that this burnt hut belonged to a late period in the occupation of Mapungubwe, and that these beads, all of which are so closely related to the Venda Canon, are even more recent than those of the Grave Area. It is also probable that these beads represent the local currency of their period, and thus gives colour to our view, that the Venda invasion of the northern Transvaal and the desertion of Mapungubwe were more or less contemporary events.

The excellent condition in which these beads were found is doubtless

due to the fact that they were buried in the sterile material of a burnt hut, and not in a grave.

The Bambandyanalo Burial Area (Q5).

Beads were much less common at Bambandyanalo than at Mapungubwe. In Burial No. 3, we were fortunate in discovering a child's skeleton, surrounded with well-preserved pottery of a Sotho facies, and intermingled with the bones, a large number of beads, which may be classified as follows:—

Pale blue cylinders of transparent cane glass; the diameter varies between 2 and 2·5 mm. and the length is very irregular.

Pale blue cylinders of translucent cane glass, identical with those from Trench JS 2a.

Pale blue oblates of transparent cane glass, 3×2 mm.; some of these beads had been faceted.

Lemon-yellow cylinders, identical with those from JS 2a.

Black, opaque cylinders, identical with those from JS 2a.

Pale blue and light green cylinders of translucent wound glass, 8×10 mm. with a bore of 1·5 mm.; ends recessed and unworn.

The three types of small pale blue beads were present in about equal numbers; a few only of the lemon-yellows and the blacks were found, and six of the large cylinders.

Discussion.

These pale blue canes are very similar to the *Thaxa* beads of the Pedi, who recognise them as such, and the fact that a number of them are faceted, in a manner which will be dealt with later, makes it certain that they belonged to a people who used a similar bead-working technique to that of the modern Pedi. The lemon-yellow and the black may also be *Thaxa* beads, or they may be identified respectively with the *Tshinovhe* and *Mushosho* of the Venda Canon.

Regarding the large cylinders, which from their recessed ends and general proportions have been termed "Garden rollers," we have nothing to add to Beck's remarks, save that since none of them showed signs of end-wear, they must be regarded as being strictly contemporary with the small beads from the same grave. We have recently seen a smaller and much worn example of this type of bead on a string, collected by Mr. Barnard in Sekukuniland, which is now in the Museum of the Archaeological Bureau. Pieces of one of these beads have been found at Klipfontein, near Kimberley, and three of them have been recorded as surface finds at Mount Alice in Southern Rhodesia (4).

Beads from other Sites in the Limpopo Valley.

Parma (X2).

On Parma kopje a considerable excavation was made, and a small artificial pit was discovered which had been sunk to bed-rock through occupational material which yielded abundant pottery shards which we have shown elsewhere to be of Sotho origin, and similar to that found with Burial No. 3, Bambandyanalo. This pit had subsequently been filled in with sand and sealed with two layers of burnt clay. By sieving this sand we obtained a quantity of beads which were similar in every way to those which had been found on the surface, and which may be classified as:

White cylinders of opaque and semi-opaque glass, surface ivory, chalky or crackled, from 2 × 1 mm. to 3·5 × 2·5 mm.

White seed beads, striped with pink and blue, pink and green, or pink only; of similar dimensions to the whites.

Yellow cylinders of opaque cane glass; of similar dimensions to the whites.

Yellow cylinders, as last but translucent and measuring 3 × 4 mm.

Grey cylinders of opaque or translucent glass measuring 3 × 2 mm.

Turquoise-blue, opaque seeds, 2 × 1·5 mm.

Pale blue, as last.

Deep blue cylinders of opaque cane glass, varying from 3 × 2 mm. to 5 × 5 mm.

Blue hexagonals of transparent cane glass on a pale blue core, 10 × 8 mm. with a bore of 7 mm.

Deep blue annular beads of transparent wound glass, 12 × 3–4 mm.

Pink, opaque seeds, 2 × 1 mm.

Indian-red cylinders of cane glass, as before described. Some of these beads had been faceted.

Red-on-white, opaque seeds, 1·5 × 1 mm. to 3·5 × 2 mm. The larger beads are probably of wound glass.

Indian-red-on-transparent-green cylinders of cane glass, 2 × 1 mm. to 3 × 3·5 mm.

Sepia cylinders of opaque cane glass, 3 × 3 mm. The colour varies between a light and a dark sepia.

Many of these beads, particularly the deep blues, have an iridescent patina which readily flakes off.

Discussion.

The beads of this series are found on the hill sites which, fortified with rough and often loop-holed walls, became the centres of native life during

the first quarter of last century, but it is altogether probable that most of the types described had been in use for at least a generation before that time.

On stratigraphical grounds, these beads, particularly those from the pit on Parma kopje, must be regarded as being later than those from Mapungubwe and Bambandyanalo.

A comparison between these beads and those from Mapungubwe brings out several striking contrasts. It appears that the Indian-reds are the only beads which are common to both. The blacks, which in one form or another are more numerous than any other type at Mapungubwe, are infrequent on these sites, and their place is taken by the whites, which do not occur amongst the earlier beads. Other characteristic beads of the later series are the pinks, the greys, the red-on-white, the Indian-red-on-transparent-green, the striped beads, the deep blue hexagonal and annular beads, none of which were found at Mapungubwe.

This divergency of types must have been due to far-reaching causes, amongst which must be numbered a change in the provenance of the beads and in the channels by which they reached the Interior.

Beads from Singalele (T_1) *and Maryland* (R_2).

These beads have much in common with those from Parma, but the blue hexagonal and annular beads are not found amongst them. From living tradition these beads can be dated to the end of last century, and can therefore be classed as modern.

Conclusions.

From the foregoing we believe that it is evident that we have before us three distinct series of beads, which, however, merge one into the other, and prove that we are dealing with a continuous development, and not disconnected episodes.

The First Series.—The beads from the Bowl.

These are all small oblates. From the absence of ostrich egg-shell and Indian-red beads, we judge them to have more in common with the bed-rock beads from Zimbabwe than any of the other series.

This series is represented in the Venda Canon by one type only—the Sodzi.

These beads are mixed in the grave furniture of the Mapungubwe Grave Area with many examples of a series in which small cylinders of cane glass predominate, and which we have called our second series.

The Second Series.—On stratigraphical grounds it is evident that this series is later than the previous one, for all the graves were made in

occupational material, while the burnt hut in Trench JS 2a stood on a great mass of rubbish about 12 feet in depth; the beads from the Bowl were deposited before any such accumulation had taken place.

We include therefore in this series all the small irregular cylinders of cane glass found in these sites, *i.e.* Indian-reds, pale blues, lemon-yellows, and blacks. Any small oblates found with them which resembled the beads from the Bowl, we regard as survivals from the earlier series. Further, we regard the large pale blue and light green cylinders found in some of the graves as being strictly contemporary with the small beads from the same graves.

The Third Series.—On several of the fortified kopjes, beads of quite a different facies have been discovered. On Parma Kopje a large haul of these was taken in a pit which had been sunk through occupational material, which contained pottery which is known from our work at Mapungubwe and Bambandynalo to have been contemporary with our second series.

This series includes only one of the earlier types of beads, the Indian-red, and is characterised by the following: white, grey, pink, striped beads, red-on-white, Indian-red-on-transparent-green, deep blue annular, and hexagonal beads.

We believe that we have established the relative dating of these three series beyond reasonable dispute; in the following pages we shall attempt to place their actual dating on an equally secure footing.*

* Professor C. van Riet Lowe has informed us that, during the course of the excavations at Mapungubwe in 1937, a natural pit was found in the underlying rock of the Grave Area, in very similar circumstances to the one in the Bowl. In this pit small cylinders of our Second Series were found in association with Garden Roller beads and Class M_2 pottery.

In the light of this discovery it is necessary for us to modify to some extent our conclusions regarding the sequence of our First and Second Series, for it is evident that, for a time at least, both series were being used together, as there can be no doubt but that the pits of the Bowl and of the Grave Area are strictly contemporary.

We would suggest that at Mapungubwe, the First Series may be regarded as a survival from an earlier time, and used only by the Royal Clan, and thus it is found to the exclusion of all others in some of the graves. The Second series, on the other hand, we regard as being the ordinary bead currency of the period. In support of this suggestion, we would point out that a similar custom exists to-day amongst the Pedi, who permit none but members of the Royal House to wear the ancient *Thaxa* beads, which differ entirely from the beads in common use.

Professor Lowe has also reported the discovery of Second Series beads, Garden Roller beads, and Class M_2 pottery at Toupye, which is a hill-top site about 40 miles to the north-east of Serowe.

PART II.

1. The Ancestral Beads of the Venda.

During August 1934 we visited, in the company of Professor Lestrade of the University of Cape Town, the Location of Chiefs Mphephu and Sinthumule in the Louis Trichard District of the Northern Transvaal, for the purpose of studying the ancestral beads of the Venda. We have correlated the notes which we made at that time with information which has been supplied by Professor van Riet Lowe and Dr. N. J. van Warmelo, and with gleanings from Stayt, and we believe that the list which we have compiled will be found to cover most of the ground. As will be readily understood, all the information which we obtained is traditional and therefore confusing and sometimes contradictory. Apparently all our informants, as is right and proper in such cases, had slightly divergent views on many points. Mphephu told us that the beautiful necklace of *Mavhaḓwa Matshena*, fastened with a *Ndalama* and *Denga* bead clasp, which his youngest and most favoured wife was wearing, was unique. At Sinthumule's, on the other hand, we heard that such strings could still be purchased for £3, 10s. each. The Sodzi were unknown at Mphephu's but readily recognised at a neighbouring Location. Then, again, the Venda use the same name for quite different beads; for example, the Indian-red cylinders and the Indian-red-on-transparent-green oblates are both called *Mukuvhibu*, but the beads themselves are readily distinguished, for whilst the former are held in some value, the latter are dismissed out of hand as being "White-man's beads."

On the whole, we found that the Venda classified their beads as belonging to three groups, viz.:—

1. Our Beads.
2. Old Beads, not Our Beads.
3. White-man's Beads.

The First Group.

V. 1. *Sodzi.* Black, opaque oblates, 1 × 2–2·5 mm. The name also applies to small black annular beads.

V. 2. *Tshinovhe.* Black, opaque cylinders of cane glass, 2 × 3–4 mm.

V. 3. *Mushosho.* Lemon-yellow, translucent cylinders of cane glass, as last. The name is also applied to white beads.

V. 4*a*. *Maḓi.* Pale bluish green, and as last.

V. 4*b*. *Maḓi.* Pale blue, and as last.

V. 4*c*. *Maḓi, Luṱumbe lwa Maḓi.* Turquoise-blue, and as last.

V. 4*d*. *Maḓi, Mafhe.* Lapis lazuli, and as last.

V. 5. *Mukuvhibvu.* Indian-red, opaque, and as last.
V. 6. *Mase-a-mbiḓi.* Milky white, or small yellow beads.
V. 7. *Luṭumbe.* Green, opaque cylinders of cane glass, 2 × 1·5–2·5 mm.
V. 8. *Matshimbaatswina.* Black, opaque, and white, opalescent, barrel-shaped beads of wound glass, threaded alternately, 4 × 7 mm.
V. 9a. *Mavhaḓwa* or *Tshinyuke.* Light blue, hexagonal beads of cane glass on a pale blue core; the size varies between 10 × 8 mm. and 11 × 11 mm.
V. 9b. *Mavhaḓwa Matshena.* Opal, translucent beads of wound glass, 10 × 10 mm.
V. 9c. *Tshinyuke.* Annular beads of deep blue transparent wound or pressed glass, 12 × 3–4 mm.
V. 9d. *Denga.* Similar to the *Madvaḓwa*, but of a violet glass.

The Second Group.

V. 10. *Tshimbandambanda.* White oblates with pink and green stripes, 3 × 2 mm. There are several varieties of this bead.
V. 11. *Phundulu.* Similar to the last, but with blue stripes.
V. 12. *Luṭumbe Lutswu.* Black oblates of cane glass with white stripes, 2 × 4 mm.
V. 13. *Luṭumbe Lutswuku.* Green oblates of cane glass with red and white stripes, 2 × 4 mm.
V. 14. *Mungazi.* Red-on-white beads in several varieties.
V. 15. *Tshifhaha.* Small white beads. Also pinks and greys.

The Third Group.

Indian-red-on-transparent-green, and all modern beads.

These lists must not be considered as in any way exhaustive, for Dr. van Warmelo has recently supplied us with the names of the following varieties of which the details and the classification are uncertain:—

Dzefhule. A variety of yellow bead.
Dzuvha-ḽa-muṭaḓa. A bright yellow bead.
Munyai. A small black bead.
Muroxwe. Probably a green bead.
Ṱhanganwi. An ancient, small, light green or blue bead.
Ṱhuvhula. The description is at present uncertain.

To these we may add the *Limanda*, which, although it is described by Stayt as being a long, white, opaque bead, is otherwise unknown.

From the remarks made by our Venda hostesses when comparing their own ancestral beads with those which we brought from Mapungubwe, we came to the conclusion that an important factor in their estimation was the

manner in which their beads were strung on a thick thread of fibre, which completely filled the bore; and so carefully were they matched for colour, shape, and size, that the strings resembled flexible rods of glass rather than beads. As the ends of the old beads are seldom at right angles to the bore, the difficulty of matching and threading them must have been very great indeed.

We noticed that three of the strings shown to us had each a diminutive phallus, about an inch in length, threaded on to it. Two of these phalli were of ivory, but despite the fact that the third was made from the tip of a bull's horn, no special significance appeared to be attached to any of them.

Discussion.

V. 1.—These *Sodzi* are the only beads of the Venda Canon which resemble any of the beads from the Bowl at Mapungubwe, which we have placed in our First Series; that they are both old and rare is fully attested by their Venda owners.

In our opinion, it is probable that the annular variety of the *Sodzi* have been worn down to their present shape from the oblate form which we found in a mint condition in the Bowl.

V. 2 *to V.* 7.—As has been shown elsewhere, these small cylinders of the first group are very similar to the beads of our second series from Mapungubwe and Bambandyanalo. As it appears to be very probable that both of these places were deserted, either during or shortly before the date of the Venda invasion of the Northern Transvaal, it is improbable that the Mapungubwe beads were derived from the Venda. It will be shown later that these, or very similar beads, can be traced over a wide area of South Africa, and we believe that they represent a bead currency which passed muster over what is now the Transvaal, the Orange Free State, and Bechuanaland up to the latter part of the eighteenth century.

We are indebted to Professor van Riet Lowe for an exhaustive study of the *Maḓi* (our V. 4*a*, V. 4*b*, V. 4*c*, and V. 4*d*) (10), and there is little for us to add, except that while his informants classed only four types of beads with the *Maḓi*, namely the *Luṱumbe*, *Mushosho*, *Sodzi*, and *Tshifhaha*, ours were much less exclusive, and seemed to regard all the small canes of the first group on much the same footing, but since they had no white ancestral beads at all, it is evident that they did not include the *Tshifhaha* in the same category.

The *Mase-a-mbiḓi* and the *Luṱumbe* were not found at Mapungubwe, and the former do not occur in the Pedi Canon; this, coupled with the fact that the Venda beads are not faceted, indicates that the beads from the Bambandyanalo Burial No. 3, are nearer to the Pedi than the Venda

tradition. *Luṭumbe* is used by the Venda to describe any small green beads without respect to their age or value.

V. 8. *Matshimbaatswina.*—The white variety of these beads seems to have had a very wide distribution. Similar beads of wound glass are found on the sands at Pemba Island, and amongst the Masai. Another variety, with brown, cloud-like markings, is current amongst the Ambo. It appears to us to be probable that these beads were made in imitation of beads made from the central column of helical shells. A similar bead to the black variety was found at Shirbeek, and is illustrated on plate xxxvi, 6, Mapungubwe (7).

V. 9*a*. *Mavhaḍwa.*—This is another word which appears to be used to describe different types of beads, but as the word itself means, "shaped, cut or chopped," we have applied it to the hexagonal blue beads. We found that the word was also used for the *Mavhaḍwa Matshena*, and Stayt (13) gives it as an alternative for *Tombo ḽa Venda, i.e.* Venda Stones, of which one variety is opaque white with black spots. We did not find these beads amongst the Venda, but Dr. Thompson of Messina has a string of beads, found near that town, which tally closely with this description. The word *Tombo*, *i.e.* stone, is used to denote a large bead in the Shona and Venda language areas. Under it the "Garden Rollers" from Bambandyanalo were recognised by Mkombosi from the Charter District of Southern Rhodesia (9, p. 4), and the people of the Petauke District of Northern Rhodesia use it to describe a type of large bead which was introduced by Arab slave-traders during the nineteenth century.

The blue hexagonal beads are also called *Tshinyuke*, while the violet hexagonals appear to be called *Denga.* At present the *Mavhaḍwa-Tshinyuke* are rather rare, although they were common formerly, but as they were not considered pretty, they were thrown away or buried with the dead.

We heard many stories regarding the rarity of this bead, and of the value which it has in the eyes of the natives; but although our archaeological specimens were allowed by the Venda experts to be identical with their own heirlooms (a distinction they would accord to no other of our beads), we found that they were only acceptable as gifts, and on no other terms whatsoever.

As this bead is associated on many of the hill sites with the *Tshimbandambanda*, it is evidently of the same date, and we have no difficulty in accepting Beck's statement that it was exported in large quantities from Europe between 1800 and 1850 for use in the slave trade. It is probably therefore the most recent of the Venda heirloom beads, and certainly none of them was found on sites which yielded beads of our First and Second Series. It is in all respects similar to the Pedi Mpetho.

V. 9*d*. *Denga*.—The word *Denga* in Shona and Venda means the sky or the heavens, and thus it is also applied to blue beads, and more particularly, we believe, to the violet hexagonals. This bead was in use as a trade bead up to fairly recent times, and may have been the "blue cut" beads which Oates was trading in the Wankies district of Matabeleland in 1874 (12, p. 179).

The deep blue annular beads are also called *Tshinyuke*, and are found in two varieties. The earlier were made with a single thread of glass which was looped round a mandrill, the point where the ends met being clearly visible; the more recent were made of pressed glass, and examples of double and triple beads are not uncommon. Both varieties had a very wide distribution in South Africa, being found all over the Northern Transvaal and Southern Rhodesia, where they remained in use down to modern times. In the Natal Government Museum there are two magnificent strings of these beads, interspaced with opalescent beads the size of pigeon eggs, which came from Rusapi where they were used by the Manyka.

V. 10. *Tshimbandambanda*.—These beads appear to have been great favourites during the early years of the nineteenth century, and we understand that they are still in use amongst the Tshangana. The *Phundulu* is another type of this bead, which under the name of *inTotoviyane* are still used by the Zulu.

V. 10*b and V*. 10*c*. *Luṭumbe Lutswu and Luṭumbe Lutswuku*.—These beads belong to the same class as the V. 10. The *Lutswuku* were imported into Central Africa during the last decades of the nineteenth century in connection with the palm-oil trade. The Pedi include both of these beads under the name of *Kgaka Mashabi*.

V. 11. *Mungazi*.—From their association with the V. 10, we can be sure that these beads are not earlier in this setting than the beginning of last century. The name is clearly derived from the Zulu word *iGazi*, meaning blood (by which this bead is known in Zululand and Natal), and indicates the route by which the *Mungazi* were introduced into Vendaland.

The Venda Classification.

1. "Our Beads."—This first group may be further subdivided into:

(*a*) Beads which may be worn with the *Maḓi*.

The tradition regarding these beads seems to vary considerably, but generally it may be accepted that it includes most of the small coloured cylinders of cane glass numbered V. 1 to V. 7 of our list.

(*b*) Beads which may not be worn with the *Maḓi*.

Again no hard-and-fast rule can be laid down at present, but it appears that none of the larger beads of the first group, and no bead at all of the

second and third groups can be worn with the *Maḓi*. All of these beads are probably later than those included under (*a*).

We believe that all the beads of the first group are those which were current when the entire bead trade was in the hands of the natives.

2. "Old Beads, not Our Beads."—Generally speaking, these beads appear to be those which were in common use in the early years of the nineteenth century, before the native had been ousted by the European trader, but after new sources of supply had become available. Some of the types, for example the *Tshimbandambanda* and the *Mungazi*, seem to have been adopted from neighbouring peoples.

3. "White-man's Beads."—All the types of modern trade beads are included in this group.

Conclusions.

The First Series.—It will be seen from the foregoing that the beads of this series are, with the exception of the *Sodzi*, entirely unrepresented in the Venda Canon.

The Second Series.—The four Venda beads, *Tshinovhe*, *Mushosho*, *Maḓi*, and *Mukuvhibvu*, are respectively very similar to, if not identical with, the blacks, lemon-yellows, pale blues (more particularly those from Trench JS 2a), and Indian-reds of this series.

From their association with these beads, all the other small cylinders of cane glass of the Venda Canon are to be included in this series.

The larger beads of the first group of the Venda Canon, may be considered as occupying an intermediate position between our second and third series, except those which are to be included in the latter series.

On the whole, therefore, this series coincides fairly well with the first group of the Venda classification.

The Third Series.—This series includes the second group of the Venda Canon, with certain elements such as the *Mavhaḓwa* and the *Tshinyuke* and the *Denga* from their first group, and the Indian-red-on-transparent-green from their third group.

Finally, we must ascribe the differences which exist between the two classifications to the vagaries of ancient fashion, or the paucity of our archaeological material.

2. The Ancestral Beads of the Pedi.

The ancestral beads of the Pedi have not been studied to the same extent as have those of the Venda, and the following notes, which have been very largely compiled from material which Mr. W. G. Barnard of Sekukuniland has been so kind as to place at our disposal, are, we believe, the first attempt to classify these beads.

The Pedi divide their heirloom beads into two groups:

(1) The *Thaxa*, beads which can only be worn by members of the Royal House.

(2) Beads which, although highly prized, can be worn by indunas and persons of lesser rank.

The First Group.

P. 1*a*. *Thaxa.* Blue, pale to deep, opaque to transparent, small cylinders of cane glass, 2 × 3 mm.

P. 1*b*. *Thaxa.* Indian-red, as last, but all are opaque, 1 × 3 mm. to 2 × 3 mm.

P. 1*c*. *Thaxa.* Black, as last, 2 × 3 mm.

P. 1*d*. *Thaxa.* Plum, as last, but transparent, 2 × 3 mm.

P. 1*e*. *Thaxa.* Lemon and orange-yellow, as last, but translucent, 2 × 3 mm. to 3 × 4 mm.

P. 2*a*. Lemon and orange-yellow, long irregular cylinders of opaque cane glass, 5 × 6 mm., bore 1 mm.

P. 2*b*. Green, opaque, as last, 4 × 4–5 mm.

P. 2*c*. White, opaque, as last, 4·5 × 4·5–6 mm.

P. 2*d*. Violet, transparent, as last, 4·5 × 4·5–6 mm.

The Second Group.

P. 3. Lemon and orange-yellow, irregular cylinders of opaque cane glass, 6 × 3 to 10 × 16 mm.

P. 4*a*. Pale blue, translucent sphere of wound glass, 15 × 15 mm., with a 5 mm. bore.

P. 4*b*. Pale blue, opaque sphere of wound glass, 9 × 10 mm., with a 1·5 mm. bore.

P. 4*c*. Deep blue, translucent pentagonal prism of wound glass, 13 × 7 mm., with 5·5 mm. bore.

P. 5. Black to plum, long barrel of translucent wound glass, 15 × 28 mm.

P. 6*a*. Opal, short cylinders of translucent wound glass, 10 × 9 mm. to 15 × 4 mm.

P. 6*b*. Deep blue, annular, transparent wound glass, 12 × 4 mm., with irregular 7 mm. bore.

P. 6*c*. Blue, transparent cylinder of cane glass, similar to P 8*a*, 5 × 15 mm., bore 3·5 mm.

P. 7*a*. Blue, transparent, hexagonal bead of cane glass, 11 × 11 mm., bore from 3 to 5·5 mm.

P. 7*b*. Violet, transparent, and as last.

P. 8*a*. *Kgaka Mashabi*. Black, opaque short cylinders of reheated cane glass, 4×2 mm. to 4×3·5 mm., decorated with fine white longitudinal lines.

P. 8*b*. *Kgaka Mashabi*. Green opaque, as last, but the lines are red and bordered with white.

P. 9. *Mohludi*. Deep green, irregular cylinder of translucent wound glass, 4×8–9 mm., with a bore of 3·5 mm.

Discussion.

Thaxa. P. 1*a to P.* 1*e*.—The *Thaxa* beads are so irregular in length that they cannot be worked up into ornaments; they are therefore strung and wound spirally round a fibre base, about 1½ inches in diameter, to form large collars. (*Molokwane wa Thaxa*) In the example which we examined, the whole surface had been rubbed down to a perfectly cylindrical section. As the beads are very valuable, they are reused time and again, with the result that they eventually present the faceted surface noted by Beck (7, p. 104) in beads from the Petersburg District.

The Pedi have a very definite tradition that the *Thaxa*, P. 2*a*, *b*, *c*, and *d*, P. 3, and P. 4*a*, *b*, and *c*, were not imported, but were manufactured by their ancestors. As the first three of these beads are of cane glass, and the fourth of wound glass, it is evident that all could not have been made by one and the same process. We have, moreover, attempted to make beads in the traditional manner, and must confess our failure. While we see no reason to doubt the possibility of an indigenous manufacture of beads, we are confident that beads were never made by the methods described to us.

The small black, Indian-red, lemon-yellow, and pale blue beads of cane glass from Mapungubwe and Bambandyanalo are acknowledged by the Pedi to be varieties of their own *Thaxa*, which also closely resemble the small cane beads of the first group of the Venda Canon. The *Thaxa* are also used by the Ambo and the Herero, as may be seen from the collection of the beadwork of these people in the M'Gregor Museum at Kimberley.

P. 2*a to P.* 3.—These beads appear to be called *Thsupyane* and *Hlusha*, but although the Pedi are said to distinguish them, they appear to us to be very similar, the *Hlusha* (P. 3) being somewhat larger than the others. We feel we are justified in assigning P. 2*b*, P. 2*c*, and P. 2*d* to their position in our list, because they are certainly old beads. The violet, P. 2*d*, is precisely the same colour as the P. 7*b*, a bead which we believe should be dated as being later than 1850. P. 2*a* and P. 3, on the other hand, are much older beads, and may be the *Limanda* which Stayt described from Vendaland or the *Canutilho* of the Portuguese Records. One of them was found

in the Umfongosi Pan, Zululand, and three beads of very similar shape are illustrated on plate xxxix, 7, of "Mapungubwe" (7).

P. 4a and P. 4b.—These two beads appear to be called *Mabethwa*, which is the Pedi equivalent of *Mavhaḓwa*, and it is interesting to note that neither of these beads show any resemblance to their Venda namesakes, but seem to belong to the same class as the opaque white and the transparent green from Cathkin Park, or the opaque blues and the translucent whites from Umhloti.

P. 4c. Mabetlwa or Talama (by which names we are informed this bead is called) is of a very unusual type, for it is of wound glass and has been ground down to a pentagonal prism; all the angles have been worn off, and the bead shows signs of long use. It certainly justifies its Venda appellation of *Mavhaḓwa*, and it suggests the possibility that the original *Mavhaḓwa* were of wound rather than cane glass. The second name is also of interest, for *Talama* corresponds to the Venda word *Ndalama*, which is ultimately derived from the Greek word *drachma* (11, p. 124). It would appear also that *Talama* is applied to the blue hexagonals (P. 8*a*) of our list.

P. 5.—This bead (apparently called *Mahlaka* or *Nyangane*) probably belongs to the same class as the sky-blue translucent bead, DK. 4*d*, from Dingaanstadt at Babanango.

P. 6a, P. 6b, and P. 6c.—The translucent opal beads (apparently called *Matau*) P. 6*a*, are very similar to the *Mavhaḓwa Matshena*, and to a very fine string which forms part of the dress of a Herero woman in the M'Gregor Museum, Kimberley. They also appear to belong to the same class as a string of bluish-grey beads from the Mambukushu of the Okavangu marshes, now in the South African Museum.

The deep blue annular beads (P. 6*b*) are very irregular and were made by the same process as the earlier *Tshinyuke*, with which they are identical.

P. 6*c* is an unusual bead and was made in the same way as the P. 7*a*, except that it is cylindrical instead of being hexagonal.

P. 7a and P. 7b.—These beads (which we are informed are called *Mpetho*) correspond respectively with the *Mavhaḓwa* and the *Denga* of the Venda Canon.

P. 9a and P. 9b. Kgaka Mashabi.—These again are very similar to the two types of the *Luṱumbe* of the Venda, and doubtless have a similar date and place of origin. The words mean "a deceiver of merchants," but as to who the merchants were, and as to how they were deceived, history is silent.

P. 10. Mohludi.—This bead resembles so closely the large pale blue and light green cylinders from Burial No. 3 at Bambandyanalo that it was probably made by a similar method.

Conclusions.

We conclude that the *Thaxa* beads belong to a very widely spread bead currency which was in vogue over a large part of Central South Africa during the eighteenth century, and probably somewhat earlier. The oldest types, such as those from the Bowl at Mapungubwe, are absent, as are the latest beads.

We consider that all the large wound beads, whether Pedi, Venda, or Zulu, had a common origin, probably in Europe, and are not earlier than the eighteenth century, and thus fall within the scope of our second series.

The Pedi beads have much in common with the Venda Canon, but the Pedi distinguish more definitely between their earlier and their later beads.

3. The Beads of the Nama.

We are fortunate enough to possess in the writings of Wikar and Le Vaillant descriptions of the habits and ornaments of the peoples who inhabited what is now the southern part of the Mandated Territory.

Thus Wikar, writing in 1778 (16):

> "To begin with they showed me beads of all colours which in the Hottentot tongue are called Koeno. The prettiest are coloured like verdigris or hammered out copper ore. I examined them and broke them into bits; but could not make them out to be anything but glass. They come chiefly from the Zountama (*i.e.* Bergdamaras) (p. 77).
>
> "They said that every year the Zountama take cattle to the Kawep (*i.e.* Ambo) and the Blip (*i.e.* Thlaping) and in exchange for cattle get a large supply of the beads . . . but when they come to our Namacquoas they give a very few of these beads in exchange for an animal" (p. 79).

In 1785 Le Vaillant, writing of the "Greater Nimquas" (8):

"I found amongst them a particular sort of these beads, consisting of little long tubes of different colours and transparent. These being unknown at the Cape I wished to know whence these savages procured them. They informed me, that they got them by barter with the neighbouring nations, who had them only at the second hand; and that they came originally from the blacks who dwelt on the coast of the Indian sea, to the east of Africa, by whom they were fabricated. . . . Now as such an operation requires, not only for the melting, but also for the composition of the colours, considerable skill, implements and knowledge, etc., I think it may be affirmed, without any great rashness, that the negroes of the east were never masters of such an art; and that the enamels they sell to their neighbours probably came from the Portuguese colonies of Mosambique. I have in my cabinet one of these girdles of glass beads, and I can assert that it is neither of French nor Dutch manufacture" (vol. ii, p. 360).

Discussion.

It is more than probable that Le Vaillant's doubts regarding the manufacture of beads by African natives were well founded, but in view of the Pedi traditions to the contrary, there may have been some basis of fact in the stories he heard. H. D. Anders (1) quotes Dr. Vedder to the effect that these beads were obtained by the Ambo from Angola, and that the ultimate source of supply was Italy. This does not invalidate Le Vaillant's observations, for, as we shall show later, there is reason to believe that similar beads were at that time being imported by the Portuguese to both the East and the West Coasts of Africa.

We have recently had the opportunity to examine beads and ear-rings recovered by Dr. T. F. Dreyer, of the Department of Zoology, University College, Bloemfontein, from graves in this very region. The beads resemble the *Thaxa* of the Pedi and also the cane glass beads from Parma Kopje. The ear-rings are of copper and are precisely similar to those described by Dr. Sparrman as Hottentot, and illustrated on plate ii of his book (14).

Conclusions.

We believe it is reasonable to conclude on the above evidence that during the eighteenth century cane glass beads, that were obtained from the Sotho tribes of Bechuanaland, were used by the Hottentot peoples along the Orange River; and since the beads found in graves as far apart as the Orange and the Limpopo Rivers, not only resemble each other and the descriptions of Wikar and Le Vaillant, but also the rarest of the ancestral beads of the Pedi and the Venda, we conclude that all these beads had a common origin and must be assigned to a date not later than the last quarter of the eighteenth century.

4. Beads from Zululand and Natal.

(1) *Dingaanstadt, Babanango.*

These beads were collected by Professor C. van Riet Lowe who kindly submitted them to us for classification and description, which we have done under the following heads:—

DK. 1, Black.		Varying from 2×3 mm. to 3×4 mm.
DK. 2, Yellow.		Lemon-yellow, translucent, varying from 2×3 mm. to 3×4 mm.
DK. 3, Orange.	(*a*)	Translucent, $3 \times 3{\cdot}5$ mm.
	(*b*)	Amber, transparent, $2 \times 3{\cdot}5$ mm.
DK. 4, Blue.	(*a*)	Deep blue, transparent, varying from $2 \times 2{\cdot}5$ mm. to $2{\cdot}5 \times 4$ mm.

(*b*) Deep blue, translucent, varying from 2 × 2 mm. to 2 × 3 mm.

(*c*) Light blue, opaque, varying from 1 × 2 mm. to 2 × 3 mm.

(*d*) Sky-blue, translucent, reheated wound glass, 12·5 × 8 mm.

(*e*) Grey-blue, translucent cylinders, varying from 2 × 2 mm. to 4 × 4·5 mm.

DK. 5, Green. (*a*) Green, translucent, varying from 1·5 × 2 mm. to 2·5 × 3·5 mm.

(*b*) Green, transparent, 2·5 × 3 mm.

(*c*) Green, transparent, reheated wound glass, 5 × 6·5 mm.

DK. 6, Red. (*a*) Crimson-on-white, varying from 2 × 2 mm. to 2 × 4 mm.

(*b*) Plum-on-white, 5 × 5·5 mm.

(*c*) Plum, translucent glass wound on a yellow base, 7 × 8 mm.

(*d*) Plum, transparent, 2 × 3 mm.

(*e*) Indian-red, opaque, varying from 1·5 × 1·5 mm. to 2 × 2 mm.

(*f*) Indian-red, opaque on transparent green base, varying from 2 × 2 mm. to 3 × 4·5 mm.

(*g*) As last, on black base, varying from 1·5 × 1·5 mm. to 2 × 2 mm.

DK. 7, Pink. Opaque, 1·75 × 1·5 mm.

DK. 8, White. (*a*) Opaque, varying from 1 × 1·5 mm. to 2 × 3·5 mm.

(*b*) Translucent, reheated cylinders, varying from 2 × 2 mm. to 3 × 4 mm.

(*c*) Translucent on opaque, reheated cylinders, 2·5 × 3·5 mm., including several examples with a crackled surface.

DK. 9, Striped white beads. (*a*) Pink stripes, varying from 1·5 × 2·5 mm. to 2 × 3 mm.

(*b*) Blue stripes, as last.

(*c*) Pink and blue stripes, varying from 2 × 2·5 mm. to 3·5 × 4 mm.

(*d*) Pink and green stripes, 2 × 2·5 mm.

Note.—Except where otherwise stated, all these beads are small oblates.

Discussion.

This collection of beads is of the greatest importance, for we have in it an assemblage which can be dated within narrow limits, for Dingaanstadt at Babanango cannot be earlier than the commencement of his reign in 1829, and it was destroyed by Pretorius in 1838.

It is interesting therefore to find that these beads resemble, on the one hand, beads from the fortified kopjes of the Northern Transvaal, which we have learnt to associate with post-Mzilikazi Period, and, on the other, beads from such sites as those at Umhloti Dune.

Black Beads. DK. 1.—These beads resemble modern beads and have little in common with the black canes from the earlier sites or the *Thaxa* or *Tshinorhe*.

Yellow and Orange Beads. DK. 2 *and DK.* 3.—These again resemble the Umhloti beads, and also those from the Mapungubwe Grave Area.

Blue Beads. DK. 4*a and DK.* 4*b*.—These two beads are unusual; they do not appear in the Zimbabwe assemblage, and we have not met them elsewhere.

DK. 4*c*.—This bead is widely distributed; similar beads were found in bed-rock levels at Zimbabwe; they do not resemble beads from the Bowl, but are very like those from Parma.

DK. 4*d*.—This bead probably belongs to a class which includes the large wound glass beads of the Pedi and the Venda. Its occurrence at Babanango serves to confirm the late date which we assign to the whole class.

DK. 4*e*.—These grey-blue and grey beads are very plentiful on most nineteenth-century sites.

Green Beads. DK. 5*a and DK.* 5*b*.—These beads occurred in quantities on the Mapungubwe Grave Area; they were also found on several of the early nineteenth-century sites, such as Singalele, and at Umhloti.

DK. 5*c*.—This bead appears to be similar to the green glass bead from Cathkin Park and the P. 4*b* of the Pedi beads.

Red Beads. DK. 6*a*.—The crimson on white is one of the commonest beads in the world. It is therefore all the more remarkable that it does not occur on any of our sites which are earlier than the end of the eighteenth century. So far as my memory serves me not a single example was found at Mapungubwe, and we have no hesitation in assigning a late date to any site upon which it is discovered.

DK. 6*b and DK.* 6*c*.—The second of these was made by winding a translucent plum-coloured glass on an opaque yellow base, and the first was probably made in the same manner on a white base. DK. 6c were at one time very popular over a wide area and are represented in the Natal

Government Museum, Pietermaritzburg, by splendid strings from Natal, Zululand, and Rusapi in Southern Rhodesia.

DK. 6*d*.—Plum-coloured glass is due, according to Beck, to the use of manganese, which is indicative of a late date (3, p. 237), and it is only on sites which yield beads of our third series that beads of this colour have been found in any quantity.

DK. 6*e*.—These opaque Indian-red beads are distinct from those of the earlier sites, which were all irregular cylinders of cane glass, while these are either spherical or oblates.

DK. 6*f and DK.* 6*g*.—These are but variants of a single type. The Indian-red on clear green base, which occur on many sites in Southern Rhodesia, are usually larger, with a diameter of between 5 and 10 mm.; they are more irregular and are more definitely cylindrical than our beads and are probably rather earlier. The Zulus do not appear to distinguish between (*f*) and (*g*), but call them both *Amambuka*, *i.e.* a turn-coat, doubtless in allusion to the black heart under a red coat. Both beads are typical of our third series.

Pink Beads. DK. 7.—This is another bead which is typical of our third series.

White Beads. DK. 8*a*, *DK.* 8*b*, *and DK.* 8*c*.—These beads are very common on all sites on which beads of our third series occur. They were not found at Mapungubwe, the DK. 8*b* are identical with modern beads. The crackled whites have been recorded from the "Acropolis," Zimbabwe (Zimbabwe Culture, p. 240), and from Penhalonga.

Striped Beads. DK. 9*a to DK.* 9*d*.—All these are indistinguishable from the Tishimbandambanda of the Venda. They are called *inTotoviyane* by the Zulu, in allusion to the bright colouring of hopper locusts. Bryant (5, p. 221) relates that the celebrated Modjadji sent a present of these beads to Zwide (*c.* 1819), and by her witchcraft speedily encompassed the death of the old hero. But as Modjadji was also famed for control over the locusts, the story may have a double meaning. Bryant tells us that the bead trade at Shaka's court was in the hands of Portuguese half-breeds from Inhambane.

(2) *Umhloti, Dune Sites, Nos.* 3 *and* 4.

The beads from these sites fall into six classes:

UD. 1. Plum, translucent glass wound on a yellow base, varying from 5×3 mm. to 10×9 mm.

UD. 2. Light blue, opaque, and white translucent wound glass, varying from 5×7 mm. to 6×10 mm.

UD. 3. Blue hexagonal, translucent cane glass, 7×11 mm.

UD. 4. Deep blue octagonal faceted, translucent pressed glass, 10 × 14 mm., bore tapers from 3 to 1 mm.

UD. 5. Striped, deep blue on white, opaque, 2 × 3·5 mm.

UD. 6. Modern trade beads.—Black, as DK. 1; yellow, as DK. 2; orange, as DK. 3*a* and *b*; crimson transparent; flame coloured; red on white, pink, green as DK. 5*a* to *c*; small UD. 5 measuring 1 × 2 mm., and white, opaque beads varying from 1 × 2 mm. to 4 × 4 mm.

Discussion.

The beads from Umhloti form an interesting collection. The large plum on yellow are identical with DK. 6*c*. The light blues and translucent white wound glass beads are well represented in Zulu and Bhaca bead-work in the Natal Government Museum, Pietermaritzburg. The blue hexagonal is our old friend the *Mavhad̂wa-Denga-Tshinyuke*, or *Mpetho* as the Pedi call it, which is ubiquitous on the fortified kopjes of the Northern Transvaal, but is rare in Natal. The deep blue octagonal faceted is fairly common in bead-work from Pondoland, which can be dated in all probability to the middle of the last century. The light apple-green variety is coloured with uranium, and cannot be older than 1830 when that type of glass was first manufactured. Our bead shows a light apple-green at the edges in transmitted light, and may contain uranium. The deep blue striped beads, of which the smaller types can still be bought, seem to have completely ousted the more gaily coloured varieties from favour; all are called *inTotoviyane* by the Zulus. The modern trade beads seem to have continued the traditions of our third series down to the present generation, for most of the varieties which can be bought to-day are common to both.

(3) *Cathkin Park.*

An account of these interesting beads is given by Wells (17, pp. 189–190).

It appears that two distinct classes of beads were discovered:

CP. *a*. Five Venetian-red, glazed earthenware beads, 2·5 × 3·5–4 mm.

CP. *b*. One white, opaque, wound glass bead, 8 × 8 mm., and one green, transparent, wound glass bead, 12·5 × 12·5 mm.

Discussion.

The most interesting of these beads are those of earthenware. Similar beads have been found at Aasvogels Kop, near Johannesburg, and Mr. B. H. Dicke states that they are found amongst the Venda. Clay beads are still made by the Pondos, but we have never heard of them being burnt, much

less glazed. On the meagre evidence at our disposal we are inclined to agree with Mr. Dicke, who believes that they are Arab or Indian imitations of those carnelian beads which have been imported from India for ages past.

The white opaque is probably the same as our Umhloti Dune (2), and the green bead is very like the P. 4*b* of the Pedi beads.

Conclusions.

The importance of the Natal and Zululand beads lies in the fact that we have in the Babanango collection a characteristic assemblage of typical beads of our third series which can be definitely dated to between the years 1829 and 1838.

The currency of this series must not, of course, be confined within these narrow limits, for there is no reason to doubt but that the earlier series merged into it, as it in turn merges into our modern beads.

With the exception of a few sporadic examples, such as the Shupeane from Umfongosi pan, no beads of our first or second series seem to have been recorded from this area.

Summary.

We have now presented a mass of evidence from which we are able to date two out of our three series of bead types with certainty.

The third series has been dated from the beads collected at Dingaanstadt, Babanango, to the first three decades of the nineteenth century, a date which is amply supported by the frequent discovery of beads of this series on the kopjes in the Northern Transvaal, which have been fortified with rough stone walls loopholed for the use of fire-arms.

The second series can, with an almost equal certainty, be dated to the eighteenth century. The literary and the archaeological evidence for the use of beads of this series along the Orange River during the latter part of that century, is, we believe, conclusive. It also seems probable that this series was current in the Northern Transvaal during, and prior to, the Venda invasion, which can be dated at about 1750.

So far we have produced no evidence for a positive rather than a relative dating of our first series, and to obtain this evidence we must proceed to consider a completely different set of facts.

PART III.

The History of the Bead Trade.

The references to beads and the bead trade which are to be found in Theal's Records of South-Eastern Africa have been dealt with in detail

by MacIver (11, pp. 95 and 96) and Caton-Thompson (3, pp. 242 and 243), that we can summarise the little there is left for us to add as follows:—

Gaspar Correa, writing in 1512 of Cabral's visit to Sofala in 1501, describes two classes of beads (15, vol. ii, pp. 26 and 27):

(i) red cloth of Cambaya and red beads (*contas vermellias*) used in that trade;

(ii) little bells from Flanders, small transparent glass beads (*continhas de vidro cristalinas*) and other things to be found in that country.

The red beads from Cambaya and coloured beads made of clay (*contas de barro*) from Negapatam are mentioned by several writers, notably by Lavanha in his account of the wreck of the "Sao Alberto" in 1593. He also tells us that they were imported to Inhambane and were distributed from a village in the Utrecht-Newcastle district of Natal (15, vol. ii, p. 333), and that they were the size of coriander seed (2·5 × 2·5 mm.). From other writers we learn that they were to be found amongst the native peoples as far south as East London (15, vol. i, p. 225); but our most circumstantial account comes from Diogo de Couto who, writing about 1600, and describing the Portuguese settlements on the Zambesi, gives us the following particulars:—

"They also take for this trade (the barter of gold carried on from the three 'feiras' which the Portuguese maintained in Southern Rhodesia) some small beads made of potters' clay (*barro miudas*), some green and others blue or yellow, with which the necklets are made that the Kaffir women wear . . . like our rich necklaces. These beads are threaded on fibres of macosi which is like the leaves of the palm, and they make necklets of ten or twelve rows, each being a palm's length. They call them metins, which is a weight in use with them. Ten of these metins they call a lipate and twenty a lipote, which is worth a cruzado and costs in that place about forty reis. All these things are sold forthwith, and double or more than double the money is made" (15, vol. vi, p. 368).

About the same time that de Couto was describing the beads which were in use on the Zambesi, we hear that a very different type of bead was passing current in the Portuguese possessions on the other side of Africa. For we have it from the Narrative of Andrew Battell, recorded in "Purchas his Pilgrims," vol. vi, chapter 3, that about 1590 Battell was trading "long glass-beads, and round Blew, and seed beads" for ivory at "Longo," or Loango as we call the place.

In 1660, Negapatam was taken from the Portuguese by the Dutch, and thenceforward its exports of beads to South-Eastern Africa either ceased altogether or could only be carried on as contraband.

Our next information comes from the Journals of Dr. Lacerda, 1798, the Journal of P. J. Baptista, one of the Pombeiros, 1802–1811, and the

Journal of Monteiro and Gamitto, 1831–1832, all of which were edited in English by Burton in 1873, under the title of "The Lands of Cazembe."

Burton has taken a great deal of trouble in translating the numerous technical terms used by his authors in describing beads. The words *contas* or *continhas* which we find in the earlier records do not appear to have been in use at the beginning of last century, and a note to p. 26 reads:

"In the text 'Roncalha, Velorio, and other Missanga' Roncalha is explained by Monteiro and Gamitto (p. 23) to signify white stoneware beads (pedras brancas). We also read (p. 189) of Roncalha Azul (blue Roncalha) and of 'pedras Leite' or milk stones, Velorio or Avelorio is also a large opaque porcelain bead. Missanga, according to Vieyra, is synonymous with arrangoes glass beads. Constancio explains it by a string of glass beads, the same as 'Mites' which Vieyra interprets as a sort of porcelain bead used as currency in Mozambique. The word is mostly applied to the red glass or porcelains, and in the text to beads in general."

Before setting out on the journey which was to terminate with his death at Cazembe's town at the southern extremity of Lake Mweru, Dr. Lacerda had written to his friend de Sousa Coutinho:

"The entertainment of the Cazembe is magnificent . . . his legs are adorned with cowries, large white beads (*velorio*), the pipe-shaped beads (canutilho) much valued amongst them" (pp. 41 and 42).

On this word, *canutilho*, Burton remarks:

"M. Constancio derives this word from the French 'canutille' meaning 'purl,' 'filum argenteum vel aureum,' the gold or silver wire, tubular and spiral, used in embroidery. In MM. Monteiro and Gamitto, it is a bead material. They make it (p. 181) a synonym of Dórora, a pipe-shaped bead or rather bugle, 1″ long by 4 or 5 lines in breadth. In p. 189 we read 'Canutilho de todas as côres.' In Venice canutilho is called 'Pipiotei'."

P. J. Baptista mentions small *canádo* beads (p. 178). The word *canada* in Portuguese means a small street or lane; it is probable therefore that *canádo* is a variety of the *canutilho.*

On the bead trade in general, Burton states (p. 42):

"In the days of MM. Monteiro and Gamitto (1831–1832) the beads for Quilimane were white, black, green and grey; for Sena white and black, for Tete and Sofala large white, black and brick-red, and for Inhambane and Lourenço Marques of all colours."

Discussion.

We know from their records that the Portuguese took over from the Arabs the barter of gold and ivory for cloth and clay beads of Negapatam, which at the beginning of the sixteenth century had already been carried

on for several hundred years, between the East African ports and India. Despite the fact that glass beads from Europe were introduced at an early date in the conquest, the clay beads were still in demand a hundred years later, and were accepted in trade over a very wide area.

After the fall of Negapatam to the Dutch in 1660, these beads were excluded from the East African trade as contraband, and supplies had to be sought elsewhere. In these circumstances the European beads inevitably took a similar place in East African commerce to that which they had always held in Angola, and we find that the same technical terms were used to describe them at both Tete and Loanda.

This change in the character of the beads is reflected in these terms, for while in the earlier documents *contas* or its variants are always used, in later times we find such words as *velorio, roncalha* and the rest, all of which can only refer to beads of glass or a similar material, while *contas* can be used equally well for beads of clay, glass, or gold.

The term *Pedras Brancas*—white stones—is curiously like the Venda *Matombo a Venda, i.e.* Venda stones, which is used to describe the large opaque white beads with tiny black spots. These beads, which are also called *Mavhaḓwa*, include a blue and a milky white translucent variety; these may well be the *Pedras Leite* of the Portuguese.

The *Canutilho* appear to resemble the *Limanda* of the Venda, described by Stayt (13, p. 253) as "long, white, and opaque." They are certainly similar to the long beads on several strings from the Congo, now in the Ethnological Museum of the University of the Witwatersrand, and the P. 3 of the Pedi, which, however, are yellow.

We conclude, therefore, that since these beads include greys and whites, and also types from the Venda Canon, that they correspond more closely to our second and third series than with the earlier beads.

Conclusions.

The First Series.—The beads with which we have been dealing were all imported articles, and like all other imports they had to be paid for with exports, in this case gold and ivory. Now we have gleaned a considerable body of evidence regarding the conditions under which this barter was carried on, and it is a remarkable fact that, although the Arabs had been exporting gold from the East Coast for several hundred years, and had even established themselves as far inland as Tete, the natives during the sixteenth century set little intrinsic value on gold. Luiz Froes tells us that they valued cows more than gold (15, vol. ii, p. 120), and other writers have much to the same effect, and we may be sure that had the Monomotapa kept a state equal to that of Him of Mapungubwe, it could not

have escaped both the cupidity and the notice of the Portuguese adventurers. We feel we cannot, as some have done, use this lack of interest in gold as an argument for relegating the treasures which have been found in such abundance to a distant antiquity, for as late as 1932 Mowena and his son had a sufficiently clear knowledge of the whereabouts of the gold at Mapungubwe to enable them to guide the van Graans to the spot. Moreover, Neal and his co-directors of the Ancient Ruins Coy. did not happen on the hoards of the "Ancients" by chance, but by bribing the natives to betray their tribal arcana at the rate of a blanket a time.

It is evident that this changed attitude regarding gold, which led to the great accumulations at Mapungubwe and elsewhere, must have taken place after the Portuguese occupation, and we would suggest largely as the result of the example set by the Portuguese themselves. We would, therefore, date all the gold of Mapungubwe, and by consequence all the beads as well, to a period subsequent to A.D. 1500. Of this we have valuable confirmatory evidence from the records; for while we may be sure that none of the small transparent glass beads from Flanders found their way to East Africa before the advent of Cabral in 1501, it is a curious fact that none of the clay beads from Negapatam have as yet been found on an archaeological site, unless indeed we can include the clay beads from Cathkin Park amongst them. We cannot use this as an argument for dating all our sites as being later than the fall of Negapatam, but we are confident that the small bright oblates of our first series can be no older, if indeed they are not identical with Gaspar Correa's *continhas de vidro cristalinas.*

The Second Series.—The continual wars in which the Low Countries were involved from the last quarter of the sixteenth century to the beginning of the eighteenth must have reacted unfavourably on Flemish exports, and may have caused the Portuguese merchants to seek a more stable source of supply for their African trade goods in Italy, where, according to Vedder (1), the cane glass beads of our second series were manufactured.

The earliest occurrence of these beads seems to have been Dhlo-Dhlo and Matendere, where Beck dated them to the seventeenth or eighteenth century (3, p. 238). They appear to have still been in vogue on the Orange River during the last quarter of the eighteenth century, and consequently in the territory between that river and the Portuguese settlements on the East and West Coasts, but they appear to have become obsolete during the early years of the nineteenth century.

The Third Series.—The first quarter of the nineteenth century saw the rise to power of four great native rulers—Shaka, Mzilikazi, Sebituane, and Zwangendaba, who organized their people for conquest, and overran vast areas of the sub-continent between Natal and the Great Lakes. Massacre,

stock-driving, crop-burning, and the resultant starvation, reduced the native population by incredible numbers, and forced the wretched survivors into the hill-top refuges, which, defended with loopholed walls, became the centres of their tribal life until the period of the European occupation.

Wherever we examined these fortified kopjes, they yielded beads of our third series, and more recently the investigations of Professor C. van Riet Lowe at Dingaanstadt, Babanango, have established the fact that similar beads are to be found there, and thus we are able to date this series with greater precision than heretofore, to the second quarter of last century, after which, through the obsolescence of such distinctive beads as the blue hexagonals and the deep blue annulars, it passes imperceptibly into the modern beads, and so out of scope of our inquiry.

Summary.

In formulating our conclusions we have only considered beads which have not only been found in quantities, but in a number of associated types. We feel that the value of our inquiry of single specimens and unusual beads is in direct ratio to their rarity, for the small size of a bead makes it so easy to transport, and the value in which it is held by a barbarian owner may be so great that it was, and indeed is, no uncommon thing for beads to remain in use for centuries.

Our information regarding the provenance of our beads is very scanty, and we fully expect that further research will modify much of what we have put forward.

We must disclaim any desire to lay down exact dates for our series. It is more than probable that a new type of bead would only arrive at its final resting-place many years after its manufacture; thus it happens that none of our series is in any way water-tight; but although we find that the beads of the earlier of two consecutive series always occur to some extent amongst the later beads, the converse is not always the case.

Finally, we must not forget that beads were used for personal adornment, in which fashion has always taken a leading hand, even in post-mediaeval Africa.

The First Series.—Including small bright oblates, deep blue, pale blue, yellow, orange, black, and colourless.

Probably from Flanders after 1500.

The Second Series.—Including the blacks of the first series and small irregular cylinders of cane glass, Indian-red, pale-blue, lemon-yellow, and black. Also similarly shaped beads of the Venda and Pedi Canons, the wound glass beads of those Canons, and the large irregular canes of the

Pedi. The large crackled-whites and the large Indian-red-on-transparent-green cylinders from Rhodesia should probably be included in this series.

Probably from Italy after 1660.

The Third Series.—Including Indian-red cylinders and large wound glass beads from the above, and deep blue hexagonal and annulars, whites, greys, pinks, red-on-whites, Indian-red-on-transparent-green, and striped beads.

All of European manufacture after 1800.

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A POSSIBLE TECHNIQUE FOR THE INVESTIGATION OF THE EFFECT OF WATER-INSOLUBLE SUBSTANCES ON THE GROWTH OF TISSUES IN VITRO, USING ALCOHOL AS AN EXCIPIENT.

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(With four Text-figures.)

(Read April 20, 1938.)

To investigate the effect of any substance upon the growth of tissues in vitro, that substance must be presented to the explants in some easy and readily calibrated manner. In the case of substances that are water soluble this is a simple matter, but active growth-effector substances may not all be readily soluble, and it is probable that the aqueous extracts such as are under investigation by Willmer (1937) do not contain all the active principles that are present in the tissues extracted. Though extracts by non-aqueous solvents are more likely to contain all the active principles, it is not, however, a simple problem to present such extracts to the explants in an effective way. There are four methods available of varying efficiency:

1. An aqueous extract of the first extract may be made, and its effect investigated. This presupposes a definite solubility in water of the active principle concerned. This method has been used by Heaton (1926) and Drew (1927) in investigating the effect of yeast extracts on the growth of epithelia and fibroblasts.

2. A water-soluble derivative, such as a salt, of the extract could be prepared. This has been done in the case of pure carcinogenic substances, but it is not feasible in the case of an extract where many constituents of widely varying chemical constitution may be present.

3. The method employed for the investigation of organisers could be used, and a block of an inert substance such as agar-agar could be impregnated with the extract or substance and the block embedded in the clot near the explant. Diffusion of active principles could then occur from the block to the explant, but this method would be difficult to calibrate.

4. A colloidal solution or suspension of the extract or substance could be made, and this could be used as an ordinary aqueous solution, when calibration would be easy.

Method (4) is the method of choice and is being used by Pybus and

Miller (1937) for pure carcinogenic agents. The great difficulty is to get a stable colloidal solution which can be sterilised. In the case of carcinogenic agents Berenblum's (1932) method may be used; here the substance is dissolved in pyridine, a proportion of the pyridine solution is added to distilled water, and the pyridine is then dialysed away leaving a relatively stable colloidal solution. In some cases a protective agent has been used; Barnes (1935) prepared a colloidal solution of dibenzanthracene by grinding the substance with lecithin, when the resultant mixture gave a stable colloidal solution; this colloidal solution was successfully used by des Ligneris (1935) to induce apparent malignant changes in tissue cultures.

In the experiments to be described later a true colloidal solution was not aimed at, but a coarse suspension was obtained by adding a few drops of an alcoholic solution to a large volume of saline. The resultant suspensions were then tested for their effect on tissues growing in vitro in order to determine the feasibility of using such a method to compare the different growth-effector properties of various extracts and pure compounds. If suspensions of different substances gave effects statistically different from each other it could be concluded that this method of presenting water-insoluble extracts and compounds might be of use experimentally.

The method of preparing the suspension necessitates the presence in the final suspension of small concentrations of ethyl alcohol. It was therefore necessary to know what effect, if any, small concentrations of ethyl alcohol have upon growth in vitro. Kirihara (1932) finds that the growth of chick heart fibroblasts is inhibited by ethyl alcohol, and that the alcohol induces fatty degeneration in the cells; successive passages through weak or medium concentrations result in an habituation, and the inhibition becomes less marked; in the abstract of the paper, which was all that was available to me, the actual quantitative values of the terms "weak," "medium," and "strong" are not given. Singer and Hoder (1929) have investigated the effect of many different alcohols on explants of guinea-pig spleen; their results showed 2 per cent. ethyl alcohol to be fatal, 1 per cent. inhibitory, and 0·1 per cent. irritating, causing a stimulation of growth; no quantitative differences are recorded, however, nor is any mention made of histological changes in the cells. In view of the unsatisfactory work done previously it was decided to carry out a preliminary experiment on the effect of ethyl alcohol itself on tissue cultures.

General Experimental Technique and Treatment of Results.

Since the work was of the nature of a simple investigation into technique, and the results required were mainly qualitative, it was not considered necessary to use a pure strain of cells. All explants were portions from the ventricle of the heart of a nine-day chick embryo; when possible, the same

heart was used for all comparable explants, but when more explants were required than could be supplied by one heart, explants from each heart were subjected to each treatment; no further precautions were taken to standardise the explants. According to Nishibi (1929) the routine precautions short of very prolonged subculturing are not adequate, and in any case the growth of heart tissue is very regular (Ebeling, 1921). Plasma was obtained by cardiac puncture on a young adult cock; embryo extract was made from nine-day chick embryos, washed free from blood, minced fine, and then the mince was centrifuged with 5 c.c. of Tyrode solution at 3000 revolutions per minute for ten minutes, the clear supernatant fluid was used as "standard" embryo extract and is equivalent to 15 per cent. embryo juice (Willmer, 1938).

For apparent-growth investigation, in which no differentiation is made between active increase by mitosis and spread by migration, explants were grown in large Carrel Type D flasks. The explants were embedded in a clot 1 mm. thick consisting of plasma 80 per cent. and embryo extract 20 per cent. This is a denser clot than is usually advocated (*cf.* Willmer, 1933), but it has an advantage in that growth is thicker and more easily observed and measured in such a clot than in a thinner one; 8–10 explants were placed in each flask, and as soon as the clot was firm the explants were drawn with the aid of a camera lucida under a low-power objective. After incubation for 18 to 24 hours the various fluids under investigation were introduced into the respective flasks; on the 4th and again on the 6th days the fluid in the flask was removed and replaced by fresh fluid of the same concentration. The cultures were drawn daily at accurately noted times until the 8th day, when the cultures were discarded.

By measuring the areas of the camera-lucida drawings with a planimeter, the area, in arbitrary units of each culture on each day, was obtained; from this the daily area increments were calculated, and the interval in hours between successive observations being known, the growth-rates for each culture for each successive period in units per hour were calculated. To minimise possible drawing errors which might give for any one day a figure too high or too low, the growth-rates for the various periods were not taken, but instead the growth-rate at each instant of observation, which was taken to be the mean of the growth-rates before and after the instant of observation.

$$\text{Growth-rate at instant } t+x = \frac{1}{2}\left(\frac{A_x - A_t}{x} + \frac{A_y - A_x}{y}\right),$$

where A_t is area at time t.

A_x „ „ „ „ $t+x$.

A_y „ „ „ „ $t+x+y$.

Owing to the fact that the interval between successive observations is not constant but varies from 20 to 28 hours, this mean is not the same as the average growth-rate for the whole two-day period.

$$\text{Growth-rate for period } t \text{ to } (t+x+y) = \frac{A_y - A_t}{x+y}$$

The mean growth-rate of all the explants in a given flask for each day was compared graphically with the mean growth-rate for the same day of the other flasks of the series; and statistical tests were applied to determine whether the apparent differences observed between flasks receiving different treatments were significant. The test applied was the t test for the comparison of two means. Comparison by growth-rates in this manner brings out contrasts better than comparison of ordinary growth curves (Brody and Ragdale, 1923).

To investigate any effects on mitosis, cover-slip cultures were used. Explants were placed on cover-slips, flooded with plasma, and then immediately as much of the plasma as possible was removed; in this way the explant is attached to the slip by a thin film only of plasma. Drops of the various fluids being investigated were placed on the explants as soon as clotting was complete, and the slips inverted over hollow-ground slides and sealed in position. After incubation for 60 hours a good growth has usually been obtained; the slips with the attached cultures were then removed from the slide, rinsed in saline, and placed in acetic alcohol to fix the cultures. Subsequent overstaining in Delafield's haematoxylin and differentiation in acid alcohol was found to show up dividing cells well. The fixed and stained cultures were carefully examined under the microscope, and the number of mitotic figures in each culture was counted. The area of outgrowth in each was also estimated by drawing with a camera lucida and measuring the drawing with a planimeter. For each culture the mitosis index was worked out, being the ratio between area of outgrowth and number of mitoses; the smaller this index, the more growth is taking place by mitosis, since in cultures where there is an excess of migration a large ratio will be obtained unless mitosis is similarly increased, and if migration is at a standstill a very small ratio will be obtained. In a series of cultures receiving the same treatment the mean mitosis index—that is, the mean of the indices for the various cultures—may be compared with the gross growth index—that is, the ratio between the total outgrowth in the whole series to the total number of mitoses seen; the nearer these values approach to each other the more regular is the growth occurring. The results of the mitosis experiments were not analysed statistically.

Experiments.

(a) *Effect of Ethyl Alcohol.*—To determine the effect of alcohol on apparent growth two series of four flasks each were put up; 4 per cent. alcohol in saline, saline, and/or embryo extract were added to the various flasks to give in the one series 0·5 per cent., 1 per cent., and 2 per cent. ethyl alcohol in saline, and in the other series the same concentrations in half-strength embryo extract.

In the series with no added extract the cells became fatty before the end

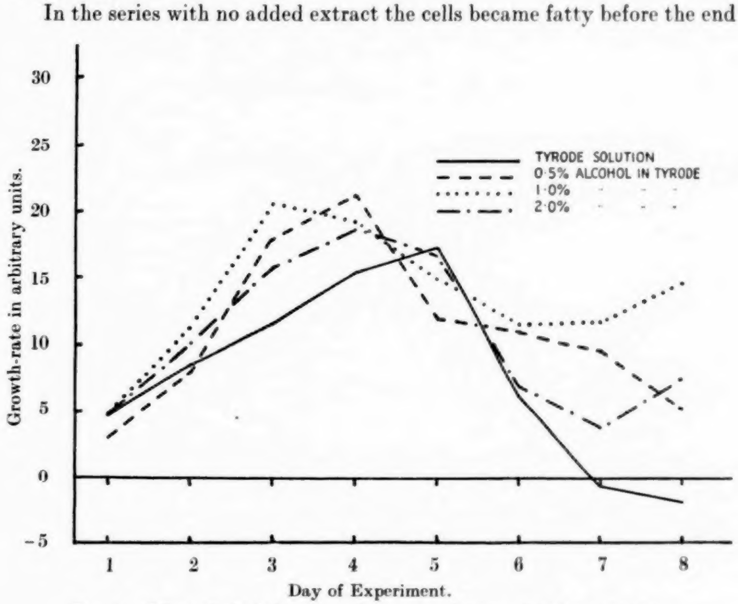

Fig. 1.—Effect of alcohol on growth-rates in absence of embryo extract. Each point a mean from at least eight cultures.

of the experimental period. In saline alone, the control flask, and 0·5 per cent. alcohol the fat granules were small and numerous; in the case of 2 per cent. alcohol each cell appeared to be filled with one large fat globule. From the graphs showing the growth-rates on different days (fig. 1) it can be seen that those cultures in the presence of alcohol attained their maximum growth-rate about the 4th day, whereas cultures grown in the absence of alcohol do not attain a maximum growth-rate until the 5th day; and whereas at the end of the experimental period the cultures in saline alone had a negative growth-rate—that is, were degenerating—the cultures with alcohol showed a growth-rate at least as good as they had at the

beginning of the experiment. On analysing the results statistically these differences are not so striking.

TABLE I.

Growth compared with Control on Various Days.

Alcohol.	3rd day.	4th, 5th, 6th day.	7th day.
% 0·5	No sig. diff.	No sig. diff.	Sig. better
1·0	Sig. better	No sig. diff.	Sig. better
2·0	No sig. diff.	No sig. diff.	No sig. diff.

In the case of the series with embryo extract, at the end of the experimental period the cells of the cultures in extract alone were showing fatty changes, but those grown in alcohol and extract showed less fat; this effect is most marked in the case of 0·5 per cent. alcohol. There is no striking difference between the growth-rate curves for cultures with alcohol and extract and that for cultures with extract alone; but the tendency for a superior growth-rate at the end of the experimental period in the case of cultures grown with alcohol is seen with both 1 per cent. and 2 per cent. alcohol (fig. 2). Statistical analysis shows:

TABLE II.

Growth compared with Control on Various Days.

Alcohol.	3rd.	4th.	5th.	6th.	7th.
% 0·5	No sig. diff.	No sig. diff.	No sig. diff.	No sig. diff.	No sig. diff.
1·0	No sig. diff.	No sig. diff.	No sig. diff.	Sig. better	No sig. diff.
2·0	Sig. worse	Sig. worse	No sig. diff.	No sig. diff.	Sig. better

In another experiment 2 per cent. alcohol in half-strength embryo extract gave a significantly worse growth-rate as compared with embryo extract alone on the 5th day.

A curious effect was noticed in some of the alcohol cultures, never noticed in cultures without alcohol, the outgrowth having the appearance of a well-defined membranous veil.

The effect of alcohol on mitosis was investigated for 2 per cent. alcohol only. In the case of cultures grown without any added extract the number of mitoses seen was very small: but more mitoses were seen in the presence

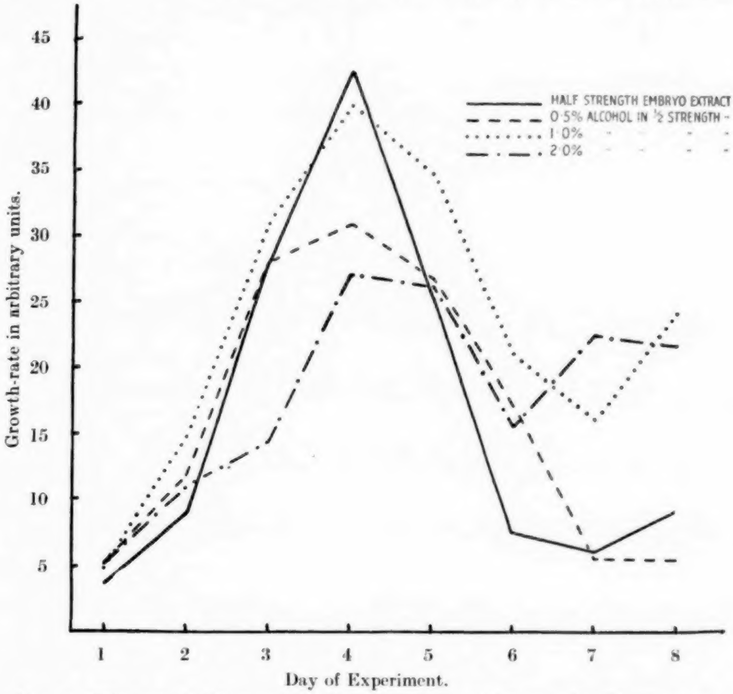

Fig. 2.—Effect of alcohol on growth-rates in presence of half-strength embryo extract. Each point a mean from at least eight cultures.

of alcohol than in the absence of it, though the nuclei of many cells in the alcohol cultures were pyknotic. Growth in the presence of alcohol was fairly regular as shown by comparing the mean and the gross mitosis indices (Table III).

In the presence of half-strength embryo extract 2 per cent. alcohol also appeared to stimulate mitosis (Table IV).

The correspondence between mean and gross mitosis indices once again indicates regularity of growth. In the presence of embryo extract no nuclear changes were seen with the alcohol.

TABLE III.

Tyrode only.				2 per cent. alcohol in tyrode.			
Culture.	Mitosis.	Out-growth.	Mitosis index.	Culture.	Mitosis.	Out-growth.	Mitosis index.
4	0	34		1	15	630	42
5	1	414	414	2	2	183	91
6	0	85		7	0	34	
7	0	198		8	0	33	
8	0	136		10	2	87	44
12	0	157					
Means		171	414	Means		193	59
Gross mitosis index .			1024	Gross mitosis index .			51

TABLE IV.

Half-strength embryo extract.				2 per cent. alcohol in half-strength extract.			
Culture.	Mitosis.	Out-growth.	Mitosis index.	Culture.	Mitosis.	Out-growth.	Mitosis index.
2	3	1363	454	1	2	222	111
3	1	106	106	2	3	423	141
4	3	280	93	3	12	1370	114
5	7	1247	178	5	2	143	72
6	2	491	246	8	10	1360	136
8	4	1202	301	9	9	1043	116
9	3	839	279	10	7	1130	162
10	6	1052	175	11	9	1173	130
11	0	71					
Means		717	230	Means		895	123
Gross mitosis index .			223	Gross mitosis index .			133

(b) *Effect of Suspensions in Dilute Ethyl Alcohol.*—Two tissue extracts were investigated; these were supplied to me by Dr. Louis Mirvish *:

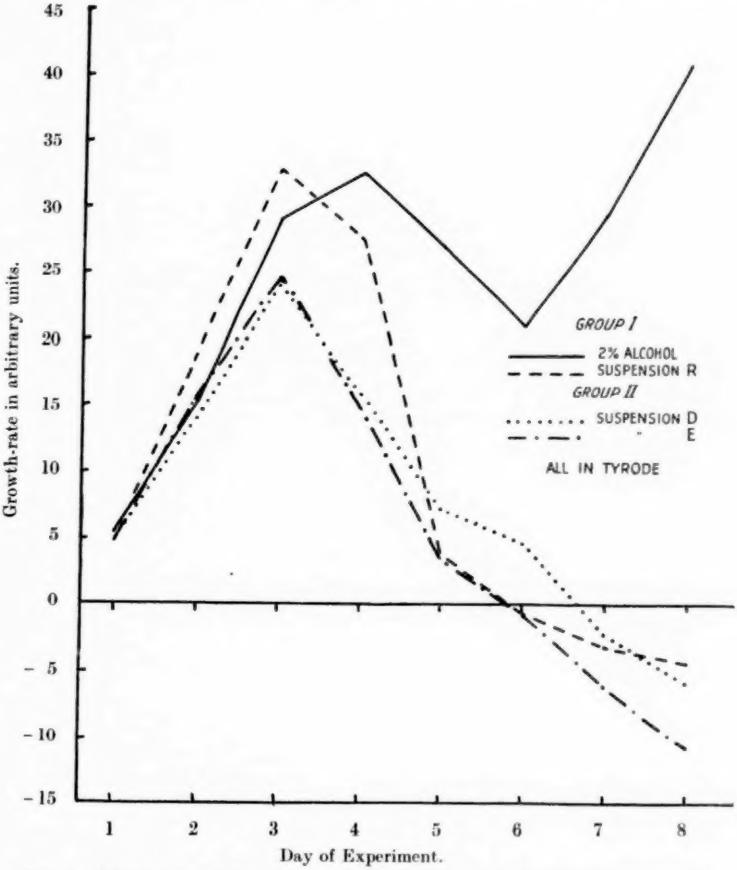

FIG. 3.—Effect of suspensions in 2 per cent. alcohol on growth-rates, in absence of embryo extract.

Each point a mean from at least sixteen cultures.

one was an extract of bovine duodenum (D), the other of bovine rectum (R). The effects of these were compared mutually and with the effect of

* *Note.*—Dr. Mirvish informs me that the extracts contained the alcohol-soluble fractions only and were prepared from bovine duodenal mucosa and bovine rectal mucosa respectively.

dilute alcohol on the one hand, and with the effect of cholesterol (C) on the other. Suspensions of D, R, and C were made in each case by dissolving a portion in absolute alcohol; the alcoholic solution was then sterilised by filtering through a Seitz filter; 0·4 c.c. of this sterile solution was added to 9·6 c.c. of sterile saline, giving a suspension in 4 per cent. alcohol. 1 c.c. portions of the suspensions were added to the flasks in investigating the effect on apparent growth, together with 1 c.c. either of saline or of embryo extract as required, giving a concentration of 2 per cent. alcohol with 100 mg. per cent. solid in suspension, which for cholesterol is a physiological concentration. Observation of the cultures was difficult owing to the mass of suspended matter.

Two separate experiments each comprising two series of flasks, one with and the other without embryo extract, were made. From the growth-rate curves (figs. 3, 4) it appeared that growth either in suspension R or in alcohol alone was much better than growth in either of suspensions D or C, irrespective of the presence of embryo extract. For statistical purposes it was decided to treat all cultures of the corresponding series from both experiments grown in alcohol alone and in suspension R as one population, Group I, and all those in suspensions C and D as a second population, Group II. Effects on growth due to added suspended matter could not be fully developed before the 3rd day owing to the method of presenting results, and by the 5th day some cultures showed signs of degeneration, so statistical analysis of the difference was confined to the 3rd and 4th days. Analysis showed that on both days the growth-rates of the Group II population was significantly inferior to the growth-rate of the Group I population, whether embryo extract was present or not. Analysis within the groups shows that, in the absence of embryo extract, on neither day is there any significant difference between the growth-rate in suspension C and that in D, nor is there between alcohol alone and suspension R on the 3rd day, but on the 4th day growth in suspension R is significantly worse than growth in alcohol alone. In the presence of embryo extract there is no significant difference between growth-rates in alcohol alone and in suspension R on either day, nor between that in suspensions C and D on the 3rd day, but on the 4th day growth in suspension D is significantly better than growth in suspension C.

Experiments on the effect of the various suspensions on mitosis were not satisfactory. In the absence of embryo extract no growth was obtained with any suspension; in the presence of embryo extract, outgrowth only was seen with suspensions D and C, but a few mitoses were seen in cultures grown in suspension R.

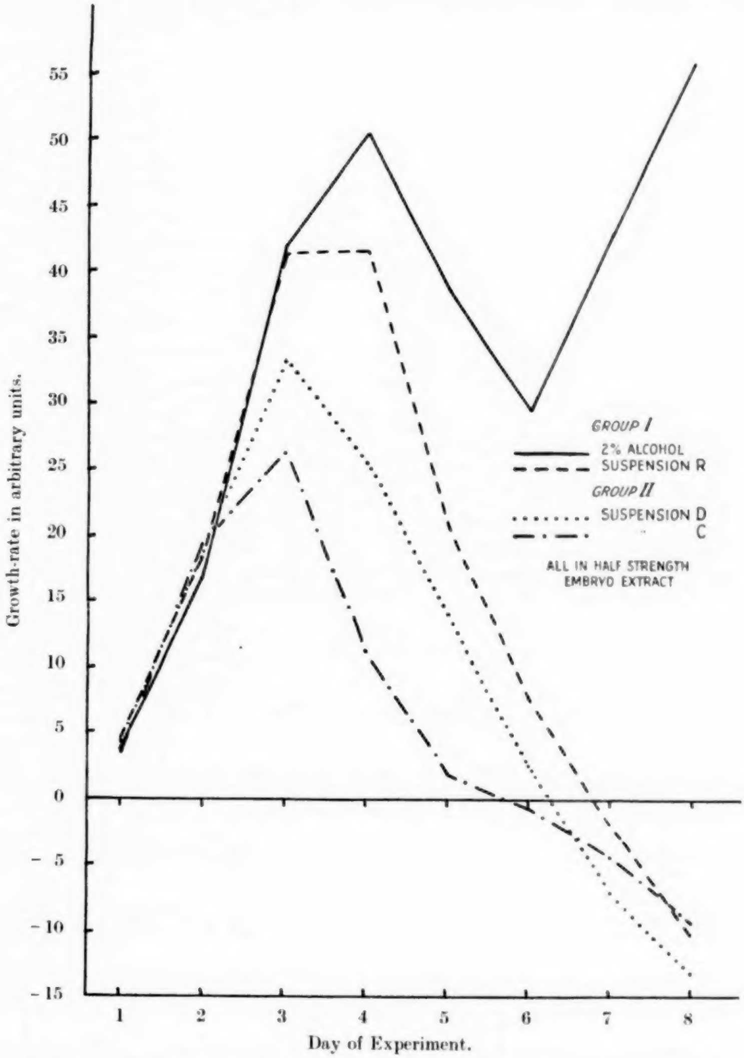

FIG. 4.—Effect of suspensions in 2 per cent. alcohol on growth-rates in presence of half-strength embryo extract.

Each point a mean from at least sixteen cultures.

Conclusions and Discussion.

(a) *Ethyl Alcohol.*—The experiments demonstrate that the alcohol does have some effect on the growth of tissues in vitro. This is a real effect, there being an actual stimulation of mitosis. In the absence of embryo extract the maximum growth-rate is obtained sooner with alcohol than without; this suggests a more rapid mobilisation of intrinsic growth energy due to an irritating effect of the alcohol; but if this were so, cultures in alcohol should degenerate more quickly, following the rapid exhaustion of the intrinsic growth energy, but this does not occur since, in the case of 0·5 per cent. and 1 per cent. alcohol anyhow, the condition of the cultures, both as regards histological appearance and growth, is better at the end of the experimental period than that of the control cultures without alcohol. Some beneficial effect of the alcohol is therefore indicated; this beneficial effect, however, is very slight, as it is masked by the presence of embryo extract. In the presence of embryo extract 2 per cent. alcohol is initially inhibitory; later in the experiment, however, it becomes beneficial; this supports Kirihara's observation that fibroblasts become habituated to alcohol, as the stimulation occurs too long after the inhibition for it to be merely the manifestation of the "rebound" that occurs following the removal of an inhibitory influence; in any case the influence has not been removed. The results also confirm those of Singer and Hoder in that at low concentrations there is inhibition; that the concentrations required to give the various effects differ in these experiments from those used by Singer and Hodel may probably be attributed to differences in the experimental technique and to the different tissues cultured.

Comparing the effects of alcohol on tissues in vitro with the effect on whole organisms, it is found that the same qualitative results were obtained by Mast and Ibara (1922) for the effect of alcohol on tadpoles; these workers found that tadpoles grown in 2/3rds and 1/3rd per cent. ethyl alcohol lived longer than those in tap-water, but that the weaker alcohol had the greater effect, and that those in alcohol grew larger than those not in alcohol. An acceleration of growth-rate was also observed by Elhardt (1930), who fed alcohol to growing chickens. The apparent "nutritive" effect of alcohol on cultures growing without embryo extract is paralleled by the observation of Bills (1924) on starving paramecia. Bills found that 1 per cent. ethyl alcohol postpones the advent of death from starvation, and that it could even restore the cultures to their former prosperity.

The effect of alcohol on tissue cultures may be compared with the effects found by other workers for other anaesthetics. Carleton and Haynes (1927) find chloroform inhibitory to growth, while ether appears to stimulate it; the concentrations used were small, being those in the

plasma of an anaesthetised animal. Rosenfeld and Weinburg (1932) immersed hanging drop cultures of chick-heart fibroblasts in ether and chloroform respectively; they noted changes in the nuclei, which became shrunken and refractile; the same change was noted in these experiments with hanging drop cultures grown in 2 per cent. alcohol alone.

(b) *Suspensions.*—The results demonstrate that suspended matter does have an effect upon the growth of tissues in vitro, and that the effect varies with the type of matter suspended. Certain suspensions (R) cause less inhibitory effect than others (D) and (C). This technique is therefore a feasible one for investigating the effect of non-water soluble extracts and compounds, as such differences would not be found if the inhibitory effect were due to the purely physical effect of the suspended matter.

Owing to the limited nature of the experiments, definite conclusions as to the significance of the differences observed in these experiments cannot be drawn; but it is interesting that the suspension of the extract from the rectum (R), where carcinoma is common, is less inhibitory than the suspension of the extract from the duodenum (D), where carcinoma is rare.

Summary.

1. 0·5 per cent., 1 per cent., and 2 per cent. ethyl alcohol stimulates real growth in explants of embryo chick heart.

2. Cultures grown in alcohol are in a healthier condition at the end of the experimental period than those grown in the absence of alcohol.

3. Two per cent. ethyl alcohol tends initially to inhibit growth, but the cells appear to become habituated to the alcohol, and later a stimulating effect is seen.

4. Suspensions made by adding alcoholic solutions of water-insoluble substance to saline have a real effect upon the growth of explants: the effect varies with the matter suspended.

Acknowledgment.

The incidental expenses of this work were defrayed by a special grant from the University of Cape Town, and certain apparatus necessary for this work and for other work in progress was purchased with the aid of the same grant.

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LECITHOSTAPHYLUS SPONDYLIOSOMAE N.SP., A TREMATODE PARASITE OF THE HOTTENTOT FISH, *SPONDYLIOSOMA BLOCHII*, FOUND IN SOUTH AFRICAN WATERS.

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(With one Text-figure.)

(Read May 18, 1938.)

In 1920, when examining various marine fishes at the Marine Aquarium, St. James, Cape Town, I found a number of parasitic Protozoa and also metazoan parasites, chiefly Cestsoda and Nematoda. However, in one Hottentot fish, *Spondyliosoma blochii* (syn. *Cantharus blochii*), caught at St. James, I was fortunate in finding an interesting small Trematode, which was assigned to the genus Lecithostaphylus Odhner. Description of the organism has been deferred in the hope of being able to make further observations, but such opportunity has not arisen, though many more Hottentot fish have been examined.

MATERIAL AND METHODS.

The material consisted of three small, yellowish-white flukes, all about the same size, obtained from the rectum of a male *Spondyliosoma blochii*. Each of these flukes was sexually mature. Their bodies were contractile and their movement somewhat feeble. In life each was about 1·5 mm. in length, exact measurement being difficult on account of their contractility. After being examined alive they were preserved in hot 70 per cent. alcohol, and subsequently one was stained with haematoxylin and the other two with acetic carmine. The specimens were cleared and examined in glycerine, without pressure.

MORPHOLOGY OF THE FLUKES (Fig. 1).

The flukes in life, when at maximum extension, were about 1·5 mm. in length. After fixation and staining they were from 1·42 mm. to 1·45 mm. in length. The maximum breadth was about three-tenths the length.

The body of each fluke was elongate and ovoid. Both ends were rounded, and the anterior end was wider than the posterior one. The cuticle was armed with fine spines.

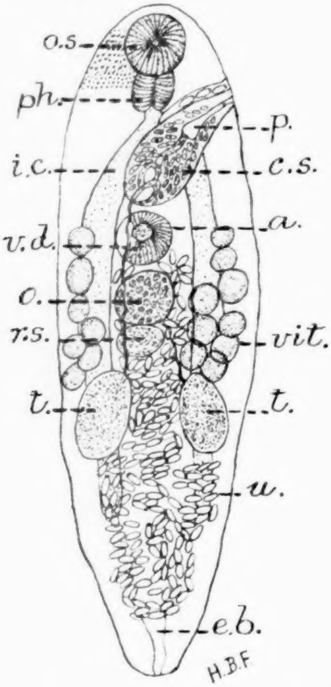

FIG. 1.—*Lecithostaphylus spondyliosomae* n.sp. Camera lucida drawing × 70 approx. *a.* acetabulum; *c.s.* cirrus sac; *e.b.* excretory bladder; *i.c.* intestinal caeca; *o.* ovary; *o.s.* oral sucker; *p.* penis; *ph.* pharynx; *r.s.* receptaculum seminis; *t.* testis; *u.* uterus; *v.d.* vas deferens; *vit.* vitallaria.

The oral sucker was sub-terminal, rounded, and fairly muscular. It measured about 0·128 mm. in diameter.

The acetabulum, situated about one-third of the length down the body, was round and muscular, practically the same diameter as the oral sucker, but was much more prominent.

The mouth opened on the oral sucker. There was a well-marked pharynx about 0·078 mm. to 0·085 mm. in length and about 0·093 mm. in breadth. The oesophagus was extremely short, in fact, practically non-existent. There were two elongate intestinal caeca that widened considerably and extended posteriorly to well beyond the testes.

The male genital system was as follows. There were two oval testes, which were slightly oblique to the long axis of the body and were almost at the same level as each other. They measured from 0·18 mm. to 0·195 mm. in length and were from 0·1 mm. to 0·128 mm. in maximum breadth. Each vas efferens arose from the inner anterior edge of the testis. The two united, and the common vas deferens was relatively long and, in the specimens examined, was situated a little way from the mid-line of the body. The cirrus sac was conical to pyriform, extending from about the mid-line to the margin of the body. The seminal vesicle was somewhat twisted or coiled and the pars prostatica well developed.

The ovary was median, situated just posterior to the acetabulum. It was rounded and measured about 0·128 mm. in greatest diameter. Posterior to the ovary there was an oval, almost median receptaculum seminis, measuring about 0·07 mm. to 0·1 mm. in diameters. The vitellaria were situated largely in the area between the intestinal caeca and the margins of the body, extending from the acetabulum to the anterior margins of the testes. The number of acini or follicles varied somewhat. In one specimen there were seven acini on one side and nine on the other; in another there were eight acini on one side and nine on the other. The vitelline ducts passed obliquely posteriorly to about the level of the receptaculum seminis and then united to form a vitelline receptacle. The ootype was relatively short. The uterus was long and convoluted, was crowded with ova, and filled the greater part of the area from the posterior end of the body to the ovary. There were numerous brownish, operculate eggs, about 0·04 mm. in length.

The excretory vesicle or bladder opened at the posterior end of the body by the excretory pore. The excretory bladder was **Y**-shaped, with a narrow stem that enlarged to form two wide diverging arms. Owing to the dense masses of ova its course could not be satisfactorily traced. Further details of the excretory system could not be obtained at the time of examination of fresh material and a further opportunity of examination of fresh material, unfortunately, has not occurred. In one specimen the excretory bladder was swollen with fluid near the excretory pore.

These minute flukes did not seem to have any noticeable effect on the host, but larger numbers might have been injurious to the fish.

Systematic Position.

There appears to be some confusion regarding the systematic position of Lecithostaphylus. A summary of the matter only can be given here. The Trematode herein described has been referred to as a member of

the genus Lecithostaphylus. This genus was instituted by Odhner in 1911 for a Trematode that he had observed from the gut of *Belone acus*, the hound fish, at Trieste and Palermo. This fluke he named *Lecithostaphylus retroflexus*. Odhner subdivided the family Zoogonidae into two subfamilies. The first subfamily, the Lecithostaphylinae, with follicular vitellaria, included the genera Lecithostaphylus, Proctophantastes and Lepidophyllum. The second subfamily, the Zoogoninae, with compact vitellaria, included the genera Diphtherostomum, Zoogonoides and Zoogonus.

Stafford in 1904 had described a Zoogonid Trematode from the halibut, *Hippoglossus hippoglossus*, under the name of *Steganoderma formosum*. This genus resembles Lecithostaphylus in broad general features, but differs in that it has a small pharynx, long oesophagus, and an elongate cirrus, while there seems to be no seminal receptacle.

Manter in 1925 redescribed *Steganoderma formosum* Stafford from the pyloric caeca of the halibut.

Führmann (1928), when classifying the Zoogonidae, retained the subfamily Lecithostaphylinae with Odhner's three genera. The Zoogoninae of Führmann included the genera Zoogonus Looss, Zoogonoides Odhner, Zoogoneus Nicoll, Diphtherostomum Stossich, and Steganoderma Stafford. The inclusion of the genus Steganoderma in the Zoogoninae is perhaps a misplacement in the make-up of the paper, as obviously its affinities are with the Lecithostaphylinae.

Price (1934) has described a new species of Lecithostaphylus, *L. atherinae*, from *Atherina araea*, obtained from Samana Bay, Dominican Republic. He succinctly reviews the Zoogonidae and points out that Linton (1910) had described a Trematode from *Oxyurus chrysurus* under the name of *Deretrema fusillus*, which was the same as Proctophantastes Odhner (1911), so that the latter name falls into synonymy. The genus Diplangus Linton (1910) from *Haemulon macrostomum* is added by Price to the Lecithostaphylinae.'

In 1934 an extensive work on the Trematoda of Japan by Yamaguti appeared. In a footnote on p. 397, Yamaguti states that "Lecithostaphylus Odhner (1911) should be regarded as a synonym of Steganoderma Stafford (1904)." In consequence he proposes to replace the name Lecithostaphylinae by Steganoderminae. No reasons are advanced for this view. Yamaguti describes two new species, *Steganoderma fellis* from the gall-bladder of the fish *Sillago sihama* and *Steganoderma sebastodis* from the gall-bladder of *Sebastodes inermis*. He gives good descriptions and illustrations of these two new species, which certainly can be assigned to Stafford's genus Steganoderma. Both species have a prepharynx, a long oesophagus, and caeca that terminate near the testes.

It seems to me, from the morphological evidence available, that the genera Lecithostaphylus and Steganoderma are nearly allied but are distinct from one another. The absence or presence of a long oesophagus is a sufficiently obvious feature to separate the two genera, and the sizes and proportions of the pharynges of the two genera also are different. The structure of the cirrus also may serve as an additional distinction, as also the relatively large size of the receptaculum seminis in Lecithostaphylus as contrasted with the relatively small size or even absence in Steganoderma.

The conclusion is reached that in the family Zoogonidae the subfamilies Lecithostaphylinae and Zoogoninae should be retained, while it may be necessary to add another subfamily to include Steganoderma, which, on morphological grounds, is not the same as Lecithostaphylus. As a result of Price's researches, the genus Proctophantastes Odhner must be replaced by Deretrema Linton. Two new genera, created by Yamaguti, Paralepidophyllum and Urinatrema, both have a short oesophagus, which would place them near Lecithostaphylus.

Two species of Lecithostaphylus have previously been described, *Lecithostaphylus retroflexus* Odhner (1911) and *L. atherinae* Price (1934). The species of Lecithostaphylus newly described here from *Spondyliosoma blochii* differs from *L. retroflexus* in shape, particularly of the posterior end of the body, in having more oblique testes and rather fewer vitelline follicles. It differs from *L. atherinae* in lacking prominent shoulders, in having entire and not lobulated ovary and testes and in having far fewer and larger vitelline acini or follicles. In consequence of the foregoing, the Zoogonid Trematode from *Spondyliosoma blochii* is considered to be a distinct species and is named *Lecithostaphylus spondyliosomae* n.sp., with characters as herein described.

With regard to the life-history of Lecithostaphylus apparantly little is known. Odhner believed that the larva of *L. retroflexus* was the cercaria described by von Graeffe (1858) under the name of *Cercaria thaumanthiadis*, which occurred in the hydromedusae of the genus Eucope. Timon-David (1933) has found agamodistomes of a Zoogonid Trematode in the musculature of Echinoderms, the metacercariae agreeing in structure with *Zoogonus mirus*, found in the intestine of *Labrus merula*. Information is not available with regard to other species of Lecithostaphylus.

Geographical Distribution of Lecithostaphylus and Steganoderma.

The geographical distribution of the nearly allied genera Lecithostaphylus and Steganoderma is of interest. *Lecithostaphylus retroflexus*

Odhner occurred in the hound fish, *Belone acus*, a member of the Belonidae, at Trieste and Palermo, Europe. The range of *Belone acus* is much more extensive, being from the Mediterranean to the West Indies and the east coast of North America. *Lecithostaphylus atherinae* Price was found in *Atherina araea*, a member of the Atherinidae, from Samana Bay, Dominican Republic. The host also occurs in the West Indies and in European waters. *Lecithostaphylus spondyliosomae* n.sp. was found in *Spondyliosoma blochii*, a member of the Sparidae, and was obtained near Cape Town, South Africa. The exact range of *S. blochii* has not been able to be ascertained,* but members of the Sparidae and allies thereto occur along all the African coasts, in North and South American waters, including the West Indies, and in Asiatic waters. The family Sparidae appears to be very widely distributed.

The species of the genus Steganoderma are also widely distributed. *Steganoderma formosum* Stafford occurs in the caeca and intestine of the halibut, *Hippoglossus hippoglossus*, belonging to the family Hippoglossidae and occurring in all northern seas. The two Japanese species have a different habitat, having been recorded from the gall-bladders of their respective hosts. *S. fellis* Yamaguti was found in the gall-bladder of *Sillago sihama*, a member of the Hoplognathidea, the "kisugo" of Japanese waters. *S. sebastoides* Yamaguti frequents the gall-bladder of *Sebastoides inermis*, a member of the Scorpaenidae, stated to be abundant at Tokyo. Physiological adaptation to life in the gall-bladder and the bile is shown by the Japanese species.

It will be noted that the genera Lecithostaphylus and Steganoderma have been found in a number of different families of marine fishes and that the species of each genus of flukes differs with the piscine host, as far as knowledge is available at present. With the present limited state of knowledge the question of host-specificity cannot be definitely determined.

Acknowledgments.

I wish to thank heartily the authorities, especially Dr. C. von Bonde, at the St. James Aquarium, Cape Town, for facilities for examining the fish, and Dr. L. R. Richardson of the Department of Zoology, McGill University, for assistance in tracing the distribution of the various piscine hosts mentioned in this paper.

* The distribution of the Hottentot is as follows: Coast of South-West Africa, Saldanha Bay, Table Bay, False Bay, and the Agulhas Bank (C. v. B.).

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THE QUARTZ HORIZONTAL INTENSITY MAGNETOMETER (Q.H.M.).

By A. Ogg, B. Gotsman, and K. W. Simpson.

(With three Text-figures.)

(Read June 15, 1938.)

The International Association of Terrestrial Magnetism and Electricity have had under consideration the question of the intercomparison of magnetic standards at different magnetic observatories throughout the world.

The Association decided to purchase 12 la Cour Horizontal Intensity Magnetometers to test their suitability for this intercomparison.

The first proposal was to divide the world into four regions and to circulate a box of three Q.H.Ms. twice a year round the magnetic observatories in each region. One station in each group of observatories was to be regularly compared with a corresponding station in each of the other groups. The scheme aimed at an intercomparison of the measurements of magnetic intensity of all the observatories taking part in the scheme.

Experience has shown that one circulation of these magnetometers takes a very long time, and it has been found necessary to modify the scheme. It has been decided, as a first step, to test the behaviour of these magnetometers after travelling long distances by post. The Magnetic Observatories at Copenhagen and Cape Town have been selected for this test.

Three Q.H.Ms. will be kept at Copenhagen, while nine will travel backwards and forwards between Copenhagen and Cape Town; a set of three to be tested each month. A large number of intercomparisons would thus be obtained sufficient for the study of their behaviour under such circumstances.

These tests have not yet started, but it has been possible to make a preliminary investigation.

The present note deals with the comparison of two Q.H.Ms., Nos. 29 and 30, belonging to the Magnetic Observatory, Trigonometrical Survey Office, Union of South Africa.

The principle of the Q.H.M. is very simple. The instrument consists

of a small magnetic needle suspended by a quartz fibre, with a small telescope attached to the suspension-tube for finding the direction of the magnetic needle. The instrument is placed on a theodolite circle, which is adjusted until the needle hangs in the magnetic meridian without torsion on the fibre. If there is a small torsion, β, on the fibre and α is the deflection of the needle from the meridian, then: H.M. $\sin \alpha = \tau\beta$, where M is the magnetic moment of the magnet, H the horizontal intensity, and τ the coefficient of torsion. If now we rotate the instrument through an angle $\pm(2\pi + \phi)$ to put a torsion of $\pm 2\pi$ on the fibre, then ϕ is the deflection of the needle due to the torsion. We have then:

$$\text{M.H.} \sin(\alpha + \phi_1) = \tau(\beta + 2\pi),$$
$$\text{M.H.} \sin(\alpha - \phi_2) = \tau(\beta - 2\pi).$$

Since α and β are small, with a proper adjustment of the instrument, we may write, as a close approximation (1),

$$\text{H} \sin\left(\frac{\phi_1 + \phi_2}{2}\right) = \frac{2\pi\tau}{\text{M}} = \text{A}.$$

If $2\phi = \phi_1 + \phi_2$, then:

$$\log \text{H} = \log \text{A} - \log \sin \phi,$$
$$\log \text{H} = \text{C} - \log \sin \phi.$$

The coefficient of torsion depends on the temperature, and the magnetic moment depends on temperature and on induction. To correct for temperature and induction we can write

$$\log \text{H} = \text{C} - \log \sin \phi + c.t - \mu \text{H} \cos \phi,$$

where c is a constant depending on the temperature coefficient of the torsion and of the magnetic moment, and μ is the coefficient of induction. The term $\mu\text{H} \cos \phi$ is small, having a value of 1 or 2 in the fifth place of decimals.

The horizontal intensities were calculated from formulae determined at Copenhagen in medio-June 1937, for Q.H.M. 29,

$$\log \text{H} = 9{\cdot}11151 - \log \sin \phi + 0{\cdot}000165t - 0{\cdot}0002\text{H} \cos \phi;$$

and for Q.H.M. 30,

$$\log \text{H} = 9{\cdot}10873 - \log \sin \phi + 0{\cdot}000162t - 0{\cdot}0002\text{H} \cos \phi.$$

If it can be shown that the torsion coefficients and the magnetic moments of these instruments remain sufficiently constant with travel and with time to give consistent results, they will have a great advantage over the usual form of portable magnetometer. A measurement can be made in about 6 minutes, while it takes from $1\frac{1}{2}$ to 2 hours for a double set of oscillations and deflections at three distances with a magnetometer of the Kew type. With careful handling of the instruments rapid changes are not to be expected. Slow changes can easily be dealt with by regular standardisation at a magnetic observatory.

The Q.H.Ms., Nos. 29 and 30, arrived in Cape Town in August 1937 and since then have been in use at the observatory. No. 29 has also been used for field observations.

The comparison is made by determining the base-line value of the magnetograph, H_0, and the scaling, h, from the equation $H_0 = H - e_H h$. The comparisons were made from observations in which the scalings were of the same order of magnitude to eliminate errors due to slight variations of the sensitivity e_H. e_H was of the order 5γ/mm. The value of H_0 obtained by the Q.H.M. 30 was always greater than that obtained by the Q.H.M. 29, the mean difference being about 2γ. The observations were made mostly with a rising temperature, and the temperature range was about 8° C.

The results tabulated in Table I show a very satisfactory behaviour of the two instruments.

TABLE I.

Comparison of the la Cour Quartz Horizontal Magnetometers, Nos. 29 and 30.

Date.	Q.H.M.	Mean temp., C.	Temp. range, C.	Mean value, H. γ.	Mean scaling, h mm.	Mean value, H_0. γ.	P.E. single obs. γ.	Diff. $H_0(30)-H_0(29)$. γ.	Observer.
22/9/37	30	22·4	5·0	14663·1	− 2·9	14677·6 ± 0·4	± 1·7		B. G.
23/9/37	29	22·0	2·0	14654·8	− 4·2	14675·7 ± 0·3	± 1·3	1·9	B. G.
30/9/37	30	19·1	1·7	14678·0	0·3	14676·5 ± 0·3	± 1·0		B. G.
30/9/37	29	21·0	0·4	14668·3	− 1·1	14673·8 ± 0·2	± 0·6	2·7	B. G.
27/1/38	30	25·8	1·2	14570·0	24·5	14447·8 ± 0·4	± 1·0		B.G.&K.W.S.
27/1/38	29	27·7	0·3	14574·7	25·8	14445·7 ± 0·3	± 0·7	2·1	K. W. S.
28/1/38	30	19·1	0·8	14620·3	34·6	14447·3 ± 0·3	± 0·3		K. W. S.
28/1/38	29	22·3	0·8	14611·5	33·3	14445·0 ± 0·1	± 0·5	2·3	K. W. S.
18/3/38	30	23·4	1·1	14627·2	34·7	14445·9 ± 0·2	± 0·5		K. W. S.
18/3/38	29	23·3	0·5	14624·4	34·3	14444·4 ± 0·1	± 0·4	1·5	K. W. S.
29/3/38	30	26·4	0·7	14609·4	31·6	14444·0 ± 0·2	± 0·4		K. W. S.
29/3/38	29	26·3	1·2	14597·6	29·7	14442·5 ± 0·2	± 0·5	1·5	K. W. S.
11/5/38	30	22·5	0·6	14591·0	28·7	14440·7 ± 0·3	± 0·6		K. W. S.
11/5/38	29	22·7	0·6	14589·6	28·8	14438·6 ± 0·3	± 0·6	2·1	B. G.
6/6/38	30	25·9	0·2	14602·0	31·3	14438·4 ± 0·2	± 0·6		B. G.
6/6/38	29	25·6	1·3	14595·7	30·2	14437·8 ± 0·2	± 0·4	0·6	B. G.
							Mean	1·8 = 0·00013 H.	

The slow change of H_0 as shown by the graph is not due to changes in the Q.H.M. constants, but is due to the magnetograph itself. H_0 as

determined by the C.I.W. Magnetometer, No. 17, was greater than the mean value determined by the Q.H.Ms. 29 and 30 by 6·1γ in September 1937 and 5·7γ in June 1938.

For field observations the Q.H.M. is eminently satisfactory, as is shown by the graphs of declination and horizontal intensity obtained from the

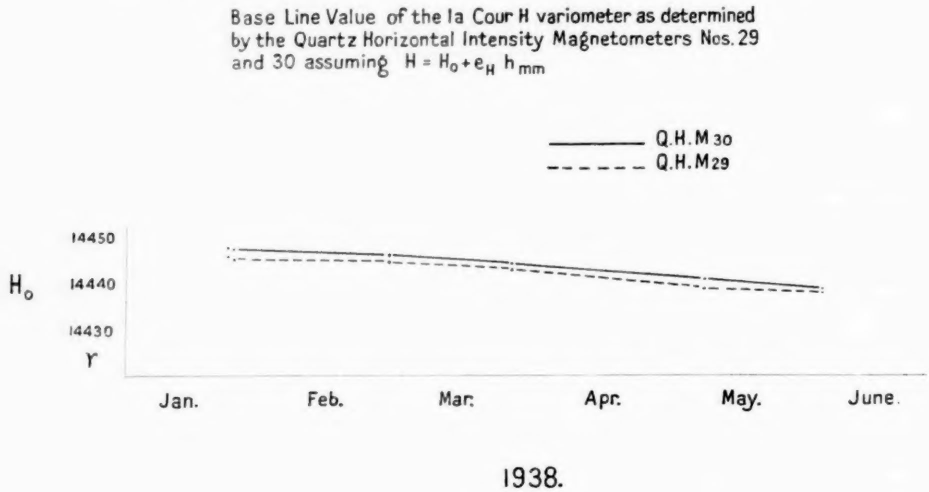


Fig. 1.

same set of observations. They show complete agreement between the diurnal variation of D and H at Buffel's Bay, about 40 miles from Cape Town, and at Cape Town Observatory, traced for corresponding points of the magnetograph at the observatory.

Note.—Since the values of H given in Table I were calculated from the approximate formula, it is advisable to determine the error resulting from imperfect elimination of initial torsion of the fibre. This error can be calculated from the expression:

$$H - H_1 = H\theta^2 \tan^2 1' / 2(1 - \cos\phi)^2, *$$

where H_1 is the value derived from the approximate equation and $2\theta = \phi_1 - \phi_2$ minutes.

The mean corrections for the observations in Table I are $+0{\cdot}7\gamma$ for Q.H.M. 29 and $+0{\cdot}2\gamma$ for Q.H.M. 30.

These corrections bring the magnetometers into still closer agreement.

(1) Det Danske Meterologiske Institut Communications Magnétiques, No. 15.

* H. H. Howe, Terr. Mag. and Atmos. Elec., vol. liii, No. 2, June 1938.

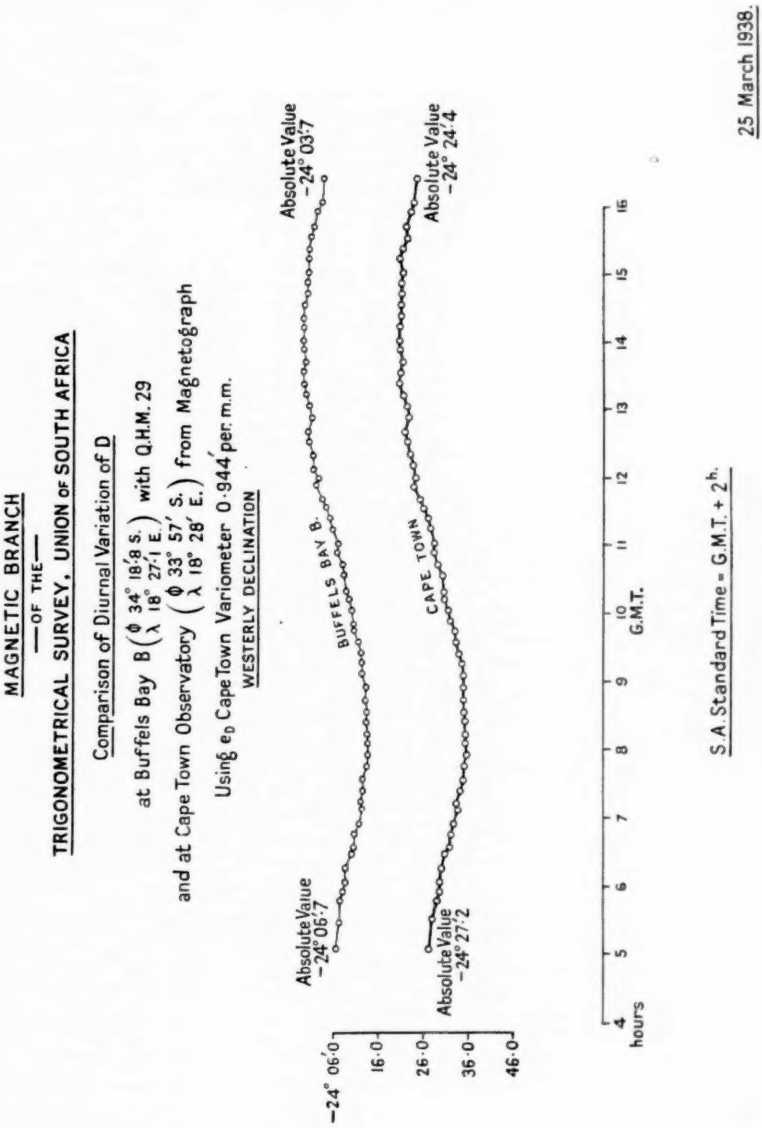

MAGNETIC BRANCH
—OF THE—
TRIGONOMETRICAL SURVEY, UNION OF SOUTH AFRICA
Comparison of Diurnal Variation of D
at Buffels Bay B (φ 34° 18′·8 S. λ 18° 27′·1 E.) with Q.H.M. 29
and at Cape Town Observatory (φ 33° 57′ S. λ 18° 28′ E.) from Magnetograph
Using e_D Cape Town Variometer 0·944′ per m.m.
WESTERLY DECLINATION
BUFFELS BAY B.
CAPE TOWN
Absolute Value −24° 05′·7
Absolute Value −24° 03′·7
Absolute Value −24° 27′·2
Absolute Value −24° 24′·4
−24° 06′·0
16·0
26·0
36·0
46·0
4 hours
5
6
7
8
9
10 G.M.T.
11
12
13
14
15
16
S.A. Standard Time = G.M.T. + 2h.
25 March 1938.

FIG. 2.

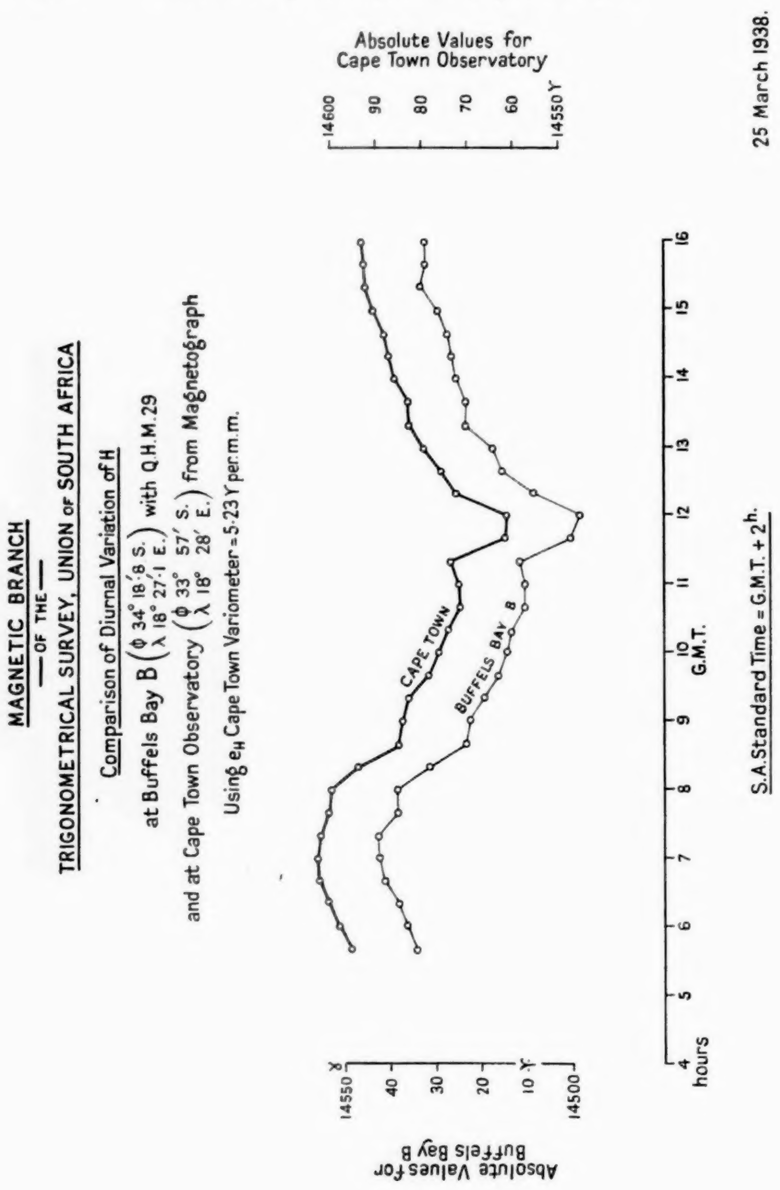

MAGNETIC BRANCH
OF THE
TRIGONOMETRICAL SURVEY, UNION OF SOUTH AFRICA
Comparison of Diurnal Variation of H
at Buffels Bay B (φ 34° 18′·8 S. λ 18° 27′·1 E.) with Q.H.M.29
and at Cape Town Observatory (φ 33° 57′ S. λ 18° 28′ E.) from Magnetograph
Using e_H Cape Town Variometer = 5·23 γ per m.m.
Absolute Values for Cape Town Observatory
14600
90
80
70
60
14550 γ
Absolute Values for Buffels Bay B
14550 γ
40
30
20
10 γ
14500
CAPE TOWN
BUFFELS BAY B
4 hours
5
6
7
8
9
10 G.M.T.
11
12
13
14
15
16
25 March 1938.
S.A. Standard Time = G.M.T. + 2h.

Fig. 3.

SOME EVIDENCE BEARING ON THE PAST HISTORY OF THE CAPE FLORA.

By Margaret R. Levyns.

(With Plate XXXIV and nine Text-figures.)

(Read July 21, 1938.)

The characteristic and peculiar flora of the extreme southern portion of Africa has long excited the attention of botanists both from the systematic and the ecological standpoints. Systematic botanists usually refer to it as the Cape flora, while ecologists have used a variety of terms the most satisfactory probably being sclerophyll, a term used by Adamson in a recently published book on the vegetation of South Africa (1).

While most botanists are in agreement that this is a very old flora, the questions of its origin and its relation to neighbouring floras introduce a considerable diversity of opinion. In this paper an attempt is made to bring together evidence which may throw light on some aspects of this controversial subject.

Geological and Archaeological Evidence.

A feature of great importance in considering the past history of the vegetation is the geological history of this part of the world since the origin of the Angiosperms. Since Cretaceous times southern Africa has suffered no major disturbance and the greater part of it has been a land surface throughout this period. There have been some incursions of the sea along the coastal belt (4), but the mountains, which at present form the main eastern and northern boundaries of the Cape flora, came into existence before the Angiosperms (3), and therefore must have provided a refuge for plant life throughout the geological period under consideration. The ice ages of Africa were past before the Angiosperms were evolved, and since Cretaceous times there is no evidence of extensive glaciation anywhere in Africa. Great volcanic activity took place in the east (6), and this must have played a part in modifying the early floras. However, Leakey (10) and others have demonstrated that man was in occupation of East Africa during the latter part of those troublous times, and disturbances which did not wipe out man would certainly not have destroyed whole floras.

A conclusion to be drawn from the foregoing remarks is that some, at any rate, of the elements of our modern flora are likely to be extremely old.

It has been assumed by some but disputed by others that the climate of southern Africa has fluctuated considerably since Cretaceous times. In places such as parts of the Transvaal and Rhodesia there is evidence to show that at one time the climate was much drier than at present, while on the other hand there are places such as parts of South-West Africa and Bushmanland where a change in the opposite direction is indicated. For example, the fossils found in an old kimberlite pipe at Banke, in Bushmanland, could only have been derived from plants and animals living in a much moister climate than that obtaining in those parts to-day (19). These results, though of much interest, could not, on account of their fragmentary nature, give us a clear picture of climatic conditions extending over a considerable period of time.

During recent years the work of archaeologists has supplemented that of the geologists in providing data from which the climates of past ages may be reconstructed. The interesting work of Leakey in East Africa has shown clearly that since man's advent there have been many changes of climate, from very dry to wet. Until recently there was very little direct evidence for similar climatic changes in southern Africa. Last year, however, a joint memoir issued by the Geological Survey and the Bureau of Archaeology (24) has provided conclusive evidence for similar alternations of arid and pluvial phases in the Vaal River basin. In the Quaternary history of this area the authors recognise three wet phases separated by arid or semi-arid periods.

As long as East Africa was the nearest place to provide clear evidence of changes of climate during the Quaternary period it was a debatable question as to whether the same or similar changes had affected the extreme south of the continent or not. However, now that it has been established in one part of South Africa that changes of climate similar to those of East Africa have occurred, it is only logical to conclude that the whole of South Africa was affected.

Unfortunately, during this stage of South Africa's past, conditions were rarely such as to favour the preservation of plant fossils. The few fossils which are known throw no light at all on the past botanical history of the country. Consequently we have to rely upon evidence from present-day floras, and from that try to reconstruct something of the past.

During the last sixteen years the writer of this paper has been engaged in studying the Cape flora, both in its ecological and in its taxonomic aspects. In the course of these studies certain evidence has been obtained which appears to throw light on the past distribution of the flora. The

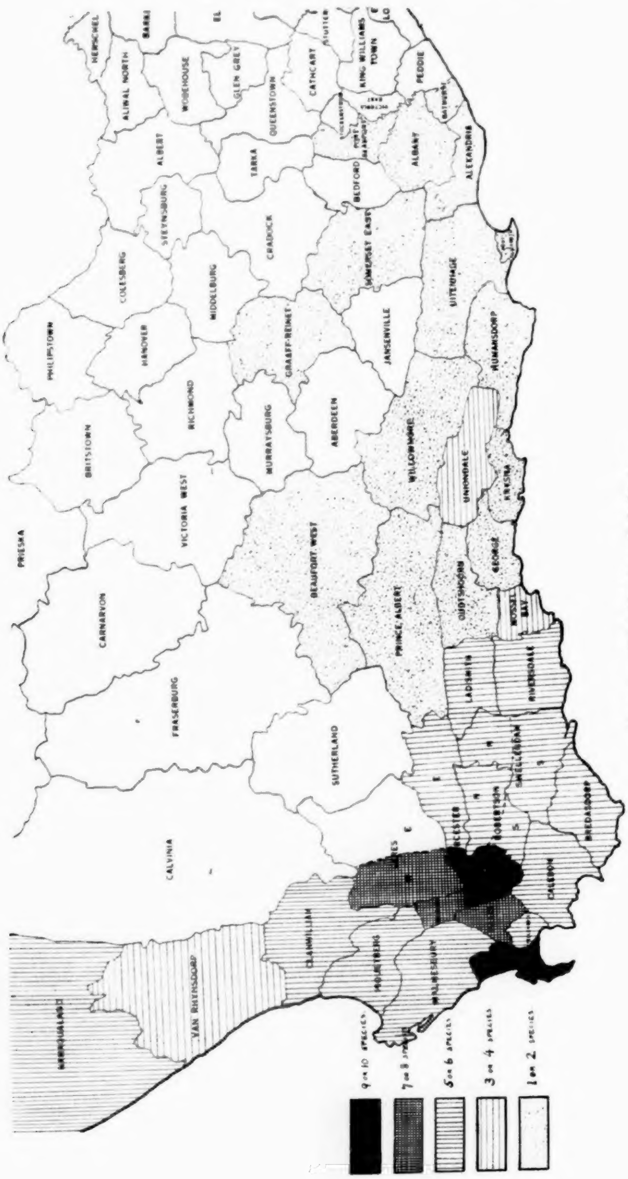
evidence is of two quite distinct kinds: (*a*) that obtained from a detailed study of selected genera, and (*b*) that derived from field observations of the interrelations of the Cape and neighbouring floras. In the following account these two aspects will be treated separately.

(a) *Evidence from the Intensive Study of Certain Genera.*

1. *Lobostemon.*—This genus is confined to the Cape Province and is closely related to the northern genus *Echium* with which it has frequently been confused. There can be little doubt, however, that it constitutes a separate genus (11). In a cytological study of the species of *Lobostemon* they were found to form a polyploid series with seven as the basic number of chromosomes (12). The author at the time at which the paper was written was unaware of work that had been done on chromosome numbers in *Echium* and commented upon the number eight which was observed in *Echium fastuosum*, a common garden plant in the neighbourhood of Cape Town. Professor Tischler very kindly drew the writer's attention to a paper (25) in which the chromosome numbers were given for six species of *Echium*. All show eight as a basic number. Thus cytology gives definite support to the view that there is a fundamental difference between these two groups of plants, and generic status may therefore be given with confidence to *Echium* and *Lobostemon*. These two genera are usually regarded as advanced members of the Boraginaceae, and are the two large genera of Engler's section Echieae. The members of this section, with the exception of *Lobostemon*, do not extend far from the neighbourhood of the Mediterranean. The so-called *Lobostemons* recorded from tropical Africa proved on examination to have none of the characters of that genus. Thus we find the two closely related genera, *Echium* and *Lobostemon*, separated from one another by the whole area of Tropical Africa.

One of the great drawbacks to work on geographical distribution in South Africa is our very inadequate knowledge of the facts in the majority of cases. In this particular instance, however, an intensive study of the genus was made over a period of nearly ten years. Expeditions covering the whole area in which the genus occurs were undertaken, and herbarium specimens from all the large herbaria in Europe and South Africa were examined. Consequently in this particular case the facts are better known than they are in many other South African genera, and it is therefore permissible to assume that they do give a true picture of the distribution of this genus.

Map 1 gives a general idea of the area occupied by the genus and the relative concentration of species. The method adopted here and in a similar map given later for *Stoebe* is to treat each division as a unit, and by means of different types of shading to indicate the numbers of species

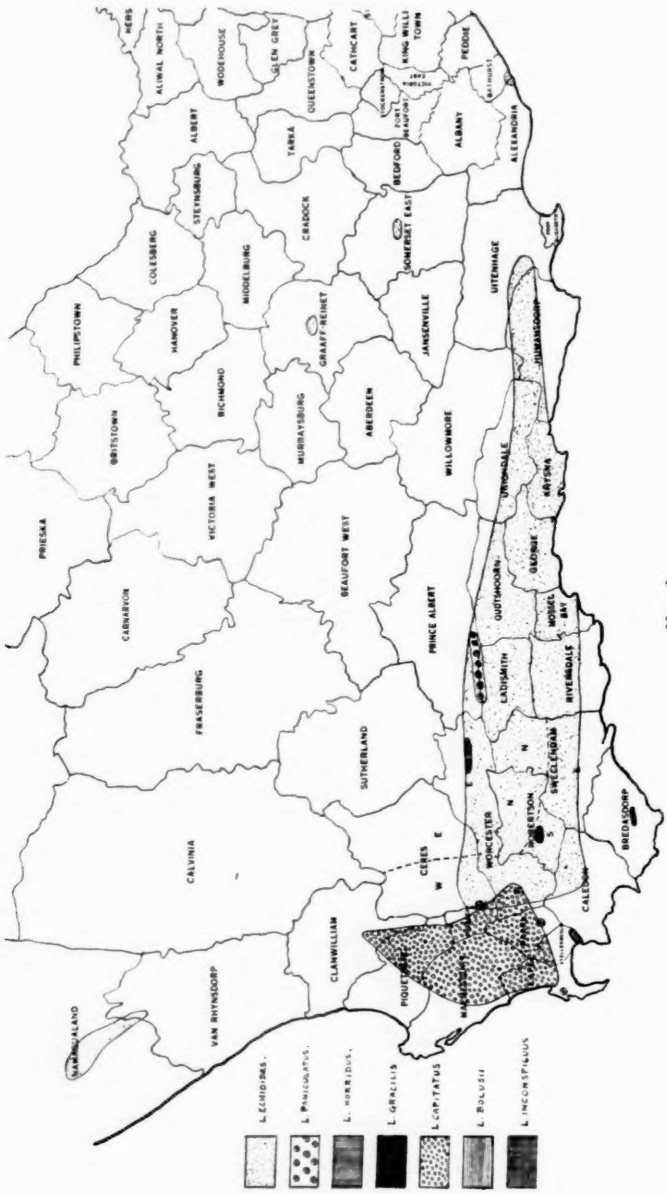


MAP 1.—Distribution of *Lobostemon.*

in each division. As a whole the method works well, but occasionally, when field workers have been active in certain areas, it gives an impression which is not indicative of the facts of distribution alone. For instance, the work of Dr. H. G. Fourcade in the Humansdorp and neighbouring divisions has made that area better known botanically than some other divisions that are probably just as rich. The same remarks apply to the flora of the Riversdale district, which is well known owing to the work of Dr. John Muir. On the other hand, certain districts, notably that of Robertson, have been much neglected by collectors and consequently the distribution maps will give a wrong impression. In the case of many genera, maps of the type used here will indicate Robertson as a poor district (28), whereas in the writer's experience the flora is rich and interesting. These facts must be borne in mind when studying maps of plant distribution, and allowances made.

It will be noted that the species show a definite concentration in the south-west and diminish in numbers both eastwards and northwards. The relatively high number found on the mountains of Namaqualand is a point of considerable interest.

In the revision of *Lobostemon* (11) a small group of species is separated to form the genus *Echiostachys*. The remaining species show a natural grouping into five sections. On taxonomic grounds the first of these, *Echioides*, with its regular flowers is regarded as the most primitive, and the groups with zygomorphic or irregular flowers as more advanced. Cytology lends support to this interpretation (12), for in the section *Trichotomi*, where the species show a range of flower-form from almost regular to quite zygomorphic, the two species with the greatest degree of zygomorphism are both tetraploids, while all the rest are diploids. Map 2 shows the distribution of the species of section *Echioides*. In order to represent all the species of the section on one map the following method has been adopted. A different type of shading is given to each species. In most cases the species occupy rather limited areas, and no special difficulties in the representation of the area occupied are encountered. In the case of *L. echioides*, however, which has the widest distribution of all the species of *Lobostemon*, some explanation is necessary. In almost all parts of the main dotted area from Worcester to Uitenhage plants belonging to this species are of frequent occurrence. The Little Karroo, however, with its semi-arid type of vegetation forms an island within this area. The reason for not leaving this island unshaded is that on two of its mountains *L. echioides* has lately been recorded, and therefore this species cannot be regarded as being absent from this area although it is not of general occurrence there. Beyond the main area of distribution *L. echioides* has been recorded from high ground in Namaqualand, Graaff Reinet, and


ALIWAL NORTH
WODEHOUSE
GLEN GREY
QUEENSTOWN
CATHCART
KING WILLIAMS TOWN
PEDDIE
ALBERT
TARKA
BEDFORD
FORT BEAUFORT
ALBANY
BATHURST
ALEXANDRIA
STEYNSBURG
CRADOCK
SOMERSET EAST
COLESBERG
MIDDELBURG
UITENHAGE
PHILIPSTOWN
HANOVER
GRAAFF-REINET
JANSENVILLE
HUMANSDORP
RICHMOND
ABERDEEN
BRITSTOWN
MURRAYSBURG
WILLOWMORE
UNIONDALE
KNYSNA
VICTORIA WEST
PRIESKA
BEAUFORT WEST
GEORGE
OUDTSHOORN
CARNARVON
PRINCE ALBERT
MOSSEL BAY
LADISMITH
FRASERBURG
RIVERSDALE
SUTHERLAND
SWELLENDAM
ROBERTSON
WORCESTER
BREDASDORP
CALVINIA
CERES
CALEDON
CLANWILLIAM
PIQUETBERG
VAN RHYNSDORP
NAMAQUALAND
L. ECHIOIDES.
L. PANICULATUS.
L. HORRIDUS.
L. GRACILIS
L. CAPITATUS
L. BOLUSII
L. INCONSPICUUS

MAP 2.

Somerset East, and also near the coast in the Alexandria and Bathurst Divisions. These outliers from the main area are of special interest and will be discussed later. *L. paniculatus* is a species which is never very common and has been recorded from rather distant localities. This discontinuity is shown on the map.

Section *Trichotomi* is a purely western one, and extends from the Cape Peninsula to Namaqualand.

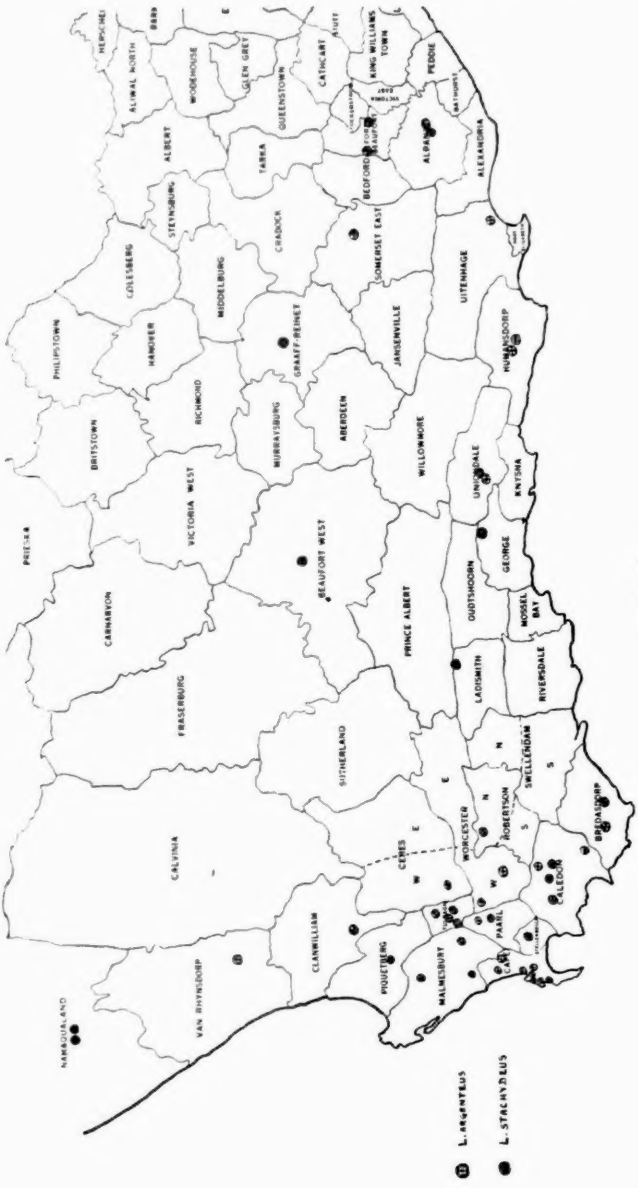
Section *Argentii* consists of two species, both of which show marked discontinuity in their areas of distribution (Map 3). In this map all the localities from which specimens have been collected are shown. *L. argenteus* is common in the west, but eastwards the records are rather scattered. From the point of view of distribution *L. stachydeus* is one of the most interesting in the genus. In no place is it really common, and each locality from which it has been recorded is widely separated from the rest. The plant is conspicuous both on account of its bright blue flowers and the extremely sharp bristles that cover the vegetative parts, so that it is not easily overlooked. The writer has collected it at the northern end of Seven Weeks Poort and on the Nieuwveld Mountains near Beaufort West. Both these localities are dry, and though the vegetation would probably be classed as sclerophyll it is of the kind only met with near the limit of endurance of this particular type of vegetation. All other records of *L. stachydeus* are from similar situations, and it appears to be able to withstand these very dry conditions better than most species of *Lobostemon*. Distribution of this type can hardly be explained in any other way than as relics of a species which was once much more abundantly represented than it is to-day. The same remark will apply to *L. echioides* of the first section, though in this case the species has been able to retain its hold over much larger areas than the two species of section *Argentii*.

Section *Fruticosi* has mainly a west to east distribution, ranging from the Cape to Port Elizabeth. The only species of this group which extends northwards is *L. fruticosus*, which peters out in the Olifants River valley and then reappears on the mountains of Namaqualand. In this respect it shows a close parallel with *L. echioides*.

Section *Grandiflori* contains three species, all with very restricted areas of distribution (Map 4). Their floral structure and distribution suggests that these species are relatively young, and occupy small areas because they have not had time to spread.

In the new genus *Echiostachys* signs of youth may be observed in that all the species are confined to the south-west corner much as in section *Grandiflori* of *Lobostemon*. In this case the areas of distribution are a little larger and overlap.

In considering the facts of distribution in these two genera it should be


L. ARGENTEUS
L. STACHYDEUS
NAMAQUALAND
VAN RHYNSDORP
CLANWILLIAM
PIQUETBERG
MALMESBURY
CAPE
PAARL
CALEDON
BREDASDORP
WORCESTER
ROBERTSON
SWELLENDAM
RIVERSDALE
MOSSEL BAY
GEORGE
KNYSNA
UNIONDALE
HUMANSDORP
UITENHAGE
ALEXANDRIA
ALBANY
PEDDIE
KING WILLIAMS TOWN
CATHCART
QUEENSTOWN
GLEN GREY
WODEHOUSE
ALIWAL NORTH
HERSCHEL
ALBERT
TARKA
BEDFORD
SOMERSET EAST
CRADOCK
STEYNSBURG
COLESBERG
MIDDELBURG
HANOVER
PHILIPSTOWN
GRAAFF-REINET
JANSENVILLE
ABERDEEN
MURRAYSBURG
RICHMOND
BRITSTOWN
WILLOWMORE
VICTORIA WEST
BEAUFORT WEST
PRIESKA
CARNARVON
PRINCE ALBERT
OUDTSHOORN
LADISMITH
FRASERBURG
SUTHERLAND
CERES
CALVINIA

MAP 3.

borne in mind that there is no obvious method of seed or fruit dispersal. The fruits are relatively large and heavy, and wind as a factor in distribution may be neglected. The fruits have no hooks or spines such as would facilitate transport by animals, and no fleshy coverings that would attract birds. Consequently their capacity for rapid spread is limited.

2. *Stoebe.*—Another genus which has been revised lately is *Stoebe* (13), a member of Compositae with light, wind-distributed fruits. Here spread may have been more rapid than in *Lobostemon*, but even making allowance for this factor, the facts of present-day distribution cannot be explained

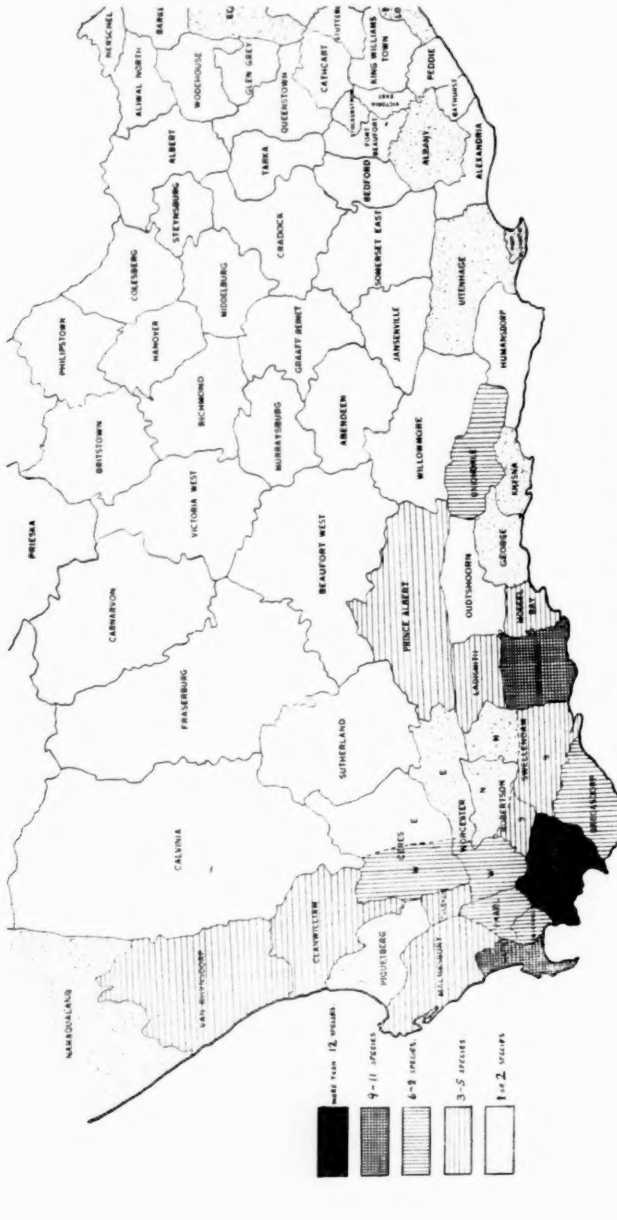
MAP 4.

without postulating for this genus the occupation of a much larger territory in the past than it occupies to-day.

The majority of the species are concentrated in the south-west, and a comparison of Map 5 with Map 1 shows that *Stoebe* and *Lobostemon* are much alike in general features. The area of greatest concentration is approximately the same, and both show the same reduction in numbers northwards and eastwards. *Stoebe*, however, extends into Tropical Africa and is also found in Madagascar and Reunion (Map 6).

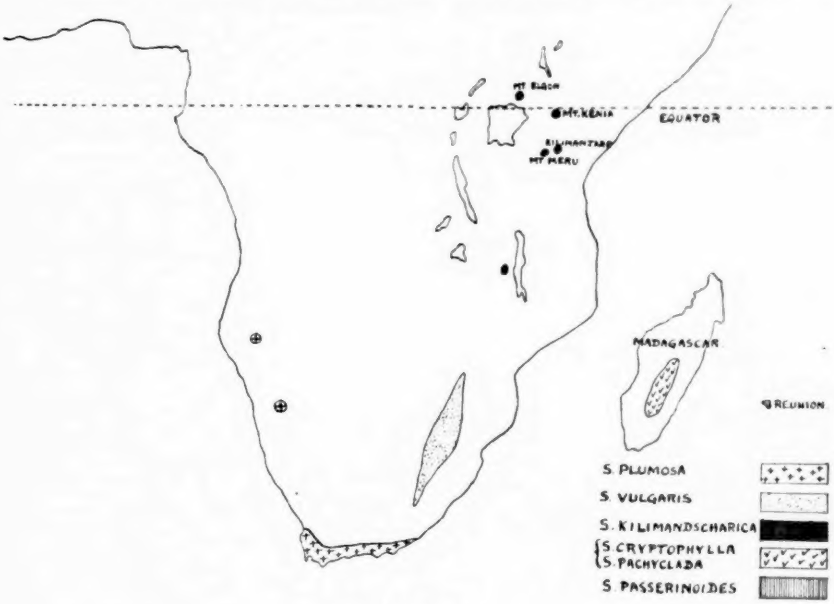
There are two well-marked sections in this genus. The first has an inconspicuously coloured corolla with small erect lobes. The second has a showy corolla either white or pink in colour, and the corolla lobes (except in the case of *S. rosea*) bend outwards. The first group contains all the species with a wide distributional range. The species of the second group all occur within the area characterised by the Cape flora.

In Map 6 the relations of a group of related species from the first section are depicted. *S. plumosa* (the *slangbos*) is a common plant of the coastal belt and reaches its limit of distribution in the Cape Province on the Giftberg in the van Rhynsdorp Division. It reappears, however, about 600 miles



MAP 5.—Distribution of *Stoebe* in the Cape Province.

farther to the north on the summit of the Auas Mountains in South-West Africa (18). There are two records of this plant in this part of South-West Africa, both at a high altitude. There are no further records till the highlands of Angola are reached, and there it was collected by the late Professor Pearson. These two outliers are separated from the main area

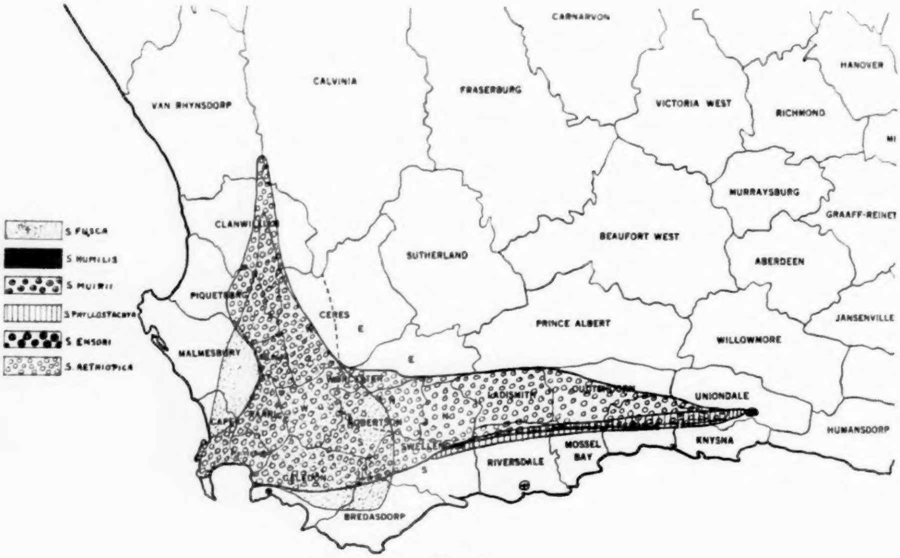


Map 6.

of distribution by large tracts of arid or otherwise unsuitable country. It is inconceivable that under present-day conditions this species can have reached these two distant localities from the south, even if the most favourable conditions of transport are conceded. *S. vulgaris* (the *slangbos* of the Transvaal) is very closely related to *S. plumosa*. The species is an eastern one, extending from the north of the Cape Province to Rhodesia. A third species *S. kilimandscharica*, which approaches *S. vulgaris* closely, occurs at high altitudes on the mountains of East Tropical Africa. It is confined to a definite zone on each of these mountains, the most northerly record being that on Mount Elgon. Three species from the same group extend beyond Africa, two being found on Madagascar and one on Reunion. Both species occurring on Madagascar are found at high altitudes in a part of the island which harbours many plants belonging to the old flora

of Madagascar, a flora which is rapidly disappearing owing to man's interference (17).

The six remaining species of the first section and all the species of the second occur within the limits of the Cape flora and do not show the marked discontinuity of the species which have just been discussed. Map 7 shows the type of distribution characteristic of the remaining species. All the



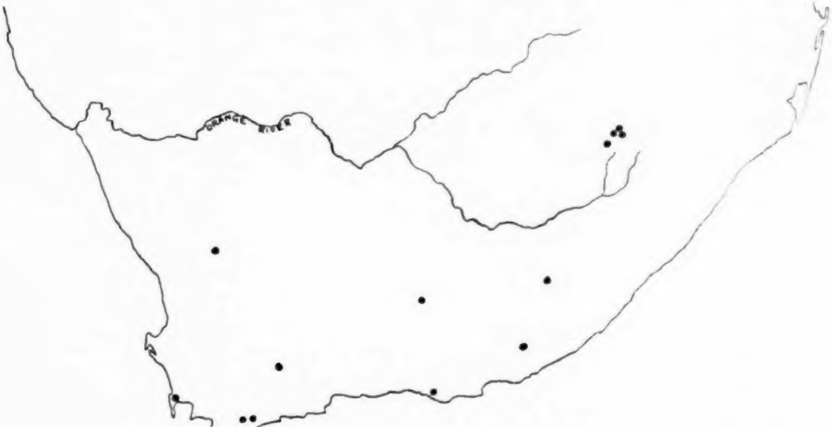
Map 7.

species shown belong to section two. It will be noted that there are no obvious discontinuities and that many of the species have a restricted range.

3. *Cliffortia.—Cliffortia*, a large genus recently monographed by Weimarck (28), shows distribution of much the same type as *Stoebe*. The genus extends into Tropical Africa, but does not occur outside Africa. A comparison of the maps given by Weimarck and those given here for *Stoebe* will show that the two genera provide close parallels. Here again certain species show marked discontinuity in their distribution, the most striking example being *C. ramosissima*, of which a map is given here (Map 8).

4. *Passerina.—Passerina* may be selected as a final example illustrating features of distribution. Thoday (26, 27) gives a full discussion of the

species of this genus which in certain respects differs from the others with which this paper deals. One of the unusual features here is the presence of two areas of concentration of species, one in the extreme south-west and the other in the east in the Uitenhage Division. This phenomenon has been observed in none of the other genera studied by the writer. In addition to the genera to which reference has been made in this paper, *Elytropappus* and *Disparago* both show a single point of concentration



MAP 8.—Distribution of *Cliffortia ramosissima*.

in the west. The same is true for such characteristic families as the Restionaceae and Bruniaceae.

Discontinuity in the areas of distribution is well illustrated by two species, *P. glomerata* and *P. montana*. *P. glomerata* extends more or less continuously from Seven Weeks Poort in the south to van Rhyns Pass in the west, following the mountain ranges and foothills. The species is characteristic of a dry type of sclerophyll which is transitional between the typical sclerophyll of the south-west and a karroid type of vegetation. There are no records of it between van Rhynsdorp and the mountains of Namaqualand, where it reappears once more after a jump of 100 miles. In South-West Africa it reappears again on the summit of Moltke Blick in the Auas Mountains (18). The interval here is approximately 500 miles. The second species mentioned, *P. montana*, is an eastern species characteristic of high ground from Kingwilliamstown to the northern Transvaal. North of this there are no records until Umtali in Rhodesia is reached, where there is an isolated record of it. Thus both in

the west and in the east instances of discontinuity of distribution are clearly demonstrated.

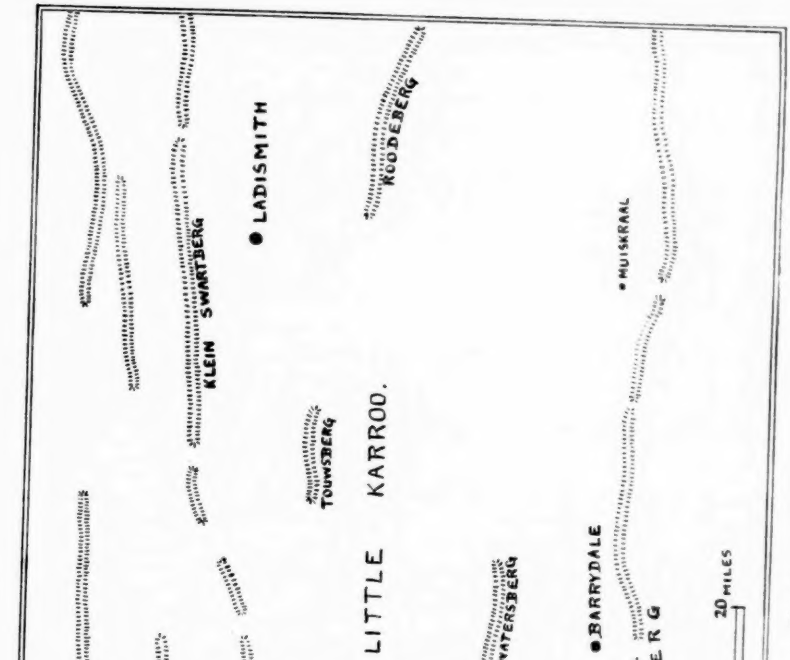
(b) *General Evidence from Field Observations.*

In the western portion of the Little Karroo we have an area of exceptional interest for the plant geographer. The Langeberg, with an altitude of between 5000 and 6000 feet, separates this area from the coastal belt. To the north lies the Klein Swartberg, the highest peaks of which reach an altitude of over 7000 feet. In between these ranges lies an undulating plain with an average altitude of a little less than 2000 feet, while rising as islands from this plain are isolated mountains (4400 to 5300 feet in height) capped by the resistant Table Mountain sandstone (Map 9). The main mountain ranges north and south are covered with vegetation of the Cape type, and so are the upper slopes of these island mountains. The lower-lying ground in between is covered by an entirely different type of plant community consisting of low succulent bush. This is quite unlike the Cape vegetation both in its ecological type and in the systematic elements comprising it.

Rainfall records are rather meagre for this region, but it is well known that the rainfall on the mountains is considerably higher than that on the plains (14). Thus the upper part of the Swartberg is recorded as having an average annual rainfall of over 20 inches. Ladismith, which lies at the foot of the mountain, has an average rainfall of 10 to 15 inches a year. The Roodeberg (one of the isolated mountains in the Karroo) has a record of about 10 inches a year. In the Karroo itself, however, the rainfall is only 5 to 10 inches a year.

A factor which the late Dr. Marloth stressed greatly was the importance of the south-east clouds which occur frequently on the mountains during the summer months. These clouds give up much of their moisture to the soil (15), and although such moisture is not registered in an ordinary rain-gauge, yet Marloth demonstrated that through the agency of reeds and small-leafed plants considerable quantities are condensed and conducted to the soil.

In this district the Cape flora survives only on those parts with a more favourable rainfall. Not very far from an average of 10 inches a year, there must be a point above which, under otherwise favourable circumstances, the Cape type of vegetation will just survive. Some kopjes running east and west a little south of Ladismith illustrate the border-line nature of the vegetation very clearly. The rocks composing them are shales belonging to the Witteberg Series and are tilted at a high angle. The northern slope is usually rather steeper than the southern. These kopjes are only about a mile from the town, and their rainfall is presumably


WITTEBERG
KLEIN SWARTBERG
LADISMITH
ROODEBERG
TOUWSBERG
ANYSBERG
THE LITTLE KARROO.
WARMWATERSBERG
BARRYDALE
MUISKRAAL
LANGEBERG
MONTAGU
WAGENBOOMSBERG
SCALE
0
10
20 MILES

Map 9.

somewhere in the neighbourhood of 10 inches a year. The northern slopes receive the maximum amount of sunshine, whereas the southern slopes, especially during the winter months, are much less exposed to the sun's rays. The evaporation rate for the northern slope will therefore be in excess of that for the southern slope. The northern slopes are covered with succulent bush of a rather luxuriant type including *Portulacaria afra*, numerous shrubby Crassulas, Cotyledons, and Mesembryanthemums. At the top of the kopje, where the strata are exposed in a series of ridges, pockets of soil are formed in between the outcrops. These soil pockets, protected by the outcrops of rocks, provide a more favourable environment for plant life than is to be found on an open slope. Here a typical Cape flora is produced with all the characteristic families, *e.g.* Restionaceae, Proteaceae, Rutaceae, Ericaceae, etc. Fig. 1 is a photograph taken on the top of one of these kopjes. The area occupied by this community is confined to the tops of the ridges, and proceeding down the southern slope its place is taken by rhenosterveld (fig. 2). Adamson (1) includes the latter type of vegetation as a form of sclerophyll, a point of view with which the writer agrees in spite of the fact that most of the characteristic families of the Cape flora are absent or nearly so from this community. In a study of the vegetation characterising the transition region between the Cape and the Karroo floras in the west, an open type of rhenosterveld frequently heralds the change from one type to the other. On the Ladismith kopjes the relations of these three different communities are clearly demonstrated. Under the most favourable circumstances the Cape flora just manages to exist. A slight movement in the direction of greater dryness, and rhenosterveld takes the place of the Cape flora. A further move in the same direction, and rhenosterveld in turn is replaced by succulent bush.

Kopjes of the type just described only occur fairly close to the Klein Swartberg, and farther out in the Karroo succulent bush covers the whole kopje.

During July 1937 a brief study was made of the floras of the island mountains of the western part of the Little Karroo. The names of the mountains are Roodeberg (4889 feet), Touwsberg (4892 feet), Warmwatersberg (4414 feet), and Anysberg (5321 feet). The positions of these are shown on the map. Each mountain, separated from its neighbours by dry stretches of the Karroo, is capped by Cape vegetation. The floras of these mountains are clearly related, and it is hoped at some future date to make a complete botanical survey of these ranges. In the meantime some features of general interest may be noted.

The plants listed below were common to all the mountains, and previous records show that they have a considerable range outside this area.

Cannomois Dregei.
Diosma ramosissima.
Elytropappus rhinocerotis.
Eriocephalus sp. (near *E. umbellulatus*).
Hypodiscus striatus.
Muraltia ericaefolia.
Passerina obtusifolia.
Thamnochortus fruticosus.

In the lists which follow some characteristic and common plants with a much more restricted range of distribution are given. For convenience they are placed in three groups: A, those which extend to the south of the Little Karroo; B, those which extend to the north; and C, those which extend both north and south. The mountains in the Karroo on which they were found are indicated by their initial letters, and their known distribution outside is given in the last column.

Group A.	
Helichrysum mucronatum (R, T).	Caledon, Swellendam, and Bredasdorp.
Metalasia Galpinii (T, A, W).	Langeberg only.
Restio foliosus (R, T, W).	Langeberg only.
Stoebe rugulosa (W).	Riversdale, Swellendam, and Robertson.
Group B.	
Lobostemon decorus (R, T).	Swartberg only.
Paranomus sp. nov. (T, A).	Swartberg only.
Phylica lanata (T, A).	Swartberg and Witteberg.
Protea sulphurea (A).	Witteberg and Wagenboomsberg.
Group C.	
Phylica purpurea (R, W).	Common on the Langeberg and south of the mountains, but has been recorded on the Swartberg.
Thoracosperma Galpinii (T, W).	Langeberg and Swartberg.

Four species were found which appear to be endemic to these mountains:

1. *Cliffortia* sp. nov. (= *C. micrantha* H. Weim. MS.). Levyns 6148. Found on Touwsberg and Anysberg.
2. *Metalasia* sp. nov. Levyns 6065. Roodeberg only.
3. *Paranomus roodebergensis* (= *Nivenia roodebergensis* Compton). Roodeberg only.
4. *Phylica* sp. nov. Levyns 6213. Warmwatersberg only.

The similarities of these mountains are striking and outweigh the differences. The clear relationship with the mountain ranges lying north and south is obvious and indicates the probability that the Cape flora was at one time much more extensive in this area than it is to-day. The fact that four endemic species have been recorded from these mountains suggests that the Cape flora capping them has been isolated sufficiently long to produce new species. Further research will probably show that there are many more endemics here than are known at present, for our knowledge of these floras is incomplete.

The value of the evidence obtained in the Little Karroo lies in its indications of the ecological relationships of the different plant communities. In view of its juxtaposition to the main area of distribution of the Cape flora, the area must have a special interest in all studies of the interrelations of these floras.

North of the Swartberg range the Cape flora disappears and is replaced by vegetation of a more arid type. North of latitude 33° and east of longitude 20° the mountains no longer show an obvious capping of the Cape flora, though traces of it are to be seen. For example, on the Boschberg at Somerset East the southern slopes show a well-defined zone of the Cape flora, starting about half-way up and reaching almost to the top. This zone contains characteristic families of the Cape flora, and its floristic relationships are unmistakable. The Cape zone is sandwiched in between Acacia scrub below and grassveld on top. On the Katberg Pass another similar zone is encountered, approximately at the same relative position. In this case forest, not Acacia scrub, occupies the lower slopes, this difference being correlated with a higher rainfall in this instance. On the Nieuwveld Mountains north of Beaufort West vegetation of a more arid type prevails, and the scanty traces of the Cape flora might easily be overlooked. However, even here where the average rainfall is just under 10 inches a year, relics of the Cape flora may be found on sheltered slopes at high altitudes. The characteristic assemblage of families of the typical Cape flora is not present, and it is only through our knowledge of the fringes of the Cape flora in other parts that the true significance of this Nieuwveld community becomes apparent. The two common plants are *Elytropappus rhinocerotis* and *Passerina obtusifolia*, forming a community of exactly the same type as that seen in the Little Karroo whenever the Cape flora is just reaching its limit. A species of Anthospermum allied to *A. aethiopicum* is also present, and so are scattered plants of *Lobostemon stachydeus* to which reference has been made earlier.

Along the edge of the Roggeveld escarpment the writer has seen no places where the typical Cape flora is developed, though it is possible that it may be found in very sheltered places. The extremely cold winters

of this part of South Africa, however, may be inimical to the development of typical sclerophyll. The nearest approach to a Cape type of vegetation is a community of which the principal constituents are *Elytropappus rhinocerotis* and a shrubby Dimorphotheca with white flowers, frequently called *Dimorphotheca cuneata*, though this name is almost certainly wrongly applied. The same community is to be found in the neighbourhood of the top of the Hex River Pass, where it forms a transition zone between the true Cape flora and a dry karroid type of vegetation. Several years ago the late Dr. Marloth in describing *Cliffortia arborea* from the Roggeveld drew attention to the plant as indicating a possible extension of the Cape flora in the past (16). The facts mentioned in this paper support that view.

The outlier of the Cape flora in Namaqualand is much more extensive and better developed than that of the Nieuwveld and Roggeveld. This has recently been described from an ecological point of view (2), and it will suffice to state here that it occupies high altitudes with a rainfall sufficient to permit the existence of this type of vegetation.

A few years ago attention was drawn to some interesting plants occurring on the top of the Auas Mountains in South-West Africa (18). This small community suggested strongly that it was an outlier of the Cape flora.

Discussion.

The striking discontinuities in distribution of certain species to which reference has been made is a phenomenon of considerable importance in considering the past history of the Cape flora. Such discontinuities can only be explained by assuming that we are dealing with relics of a more extensive distribution in the past. Discontinuity is also apparent in the general distribution of the Cape flora beyond the main area of occupation at the present day. Perrier de la Bathie (17), in his account of the vegetation of Madagascar, draws attention to the same feature there. The plant communities of that island are being rapidly changed largely owing to man's interference. It is pointed out that the recent prairie type is threatening the existence of the old flora of Madagascar, which only survives in sheltered places. On that island "Les espèces des formations végétales primitives sont disjointes et cette disjonction est un preuve manifest de la destruction de ces animaux et de ces plantes dans les espaces intermédiaires, recouverts actuellement par la prairie." These remarks may well be applied to the case of the Cape flora in South Africa. Here, however, the Cape flora holds its own in the coastal belt, and it is only outside this area that signs of discontinuity in distribution become a marked feature.

In an earlier part of this paper reference was made to recent work in support of changes of climate in South Africa during the Quaternary

period. Such changes could well explain the distribution of species of the type described in this paper. During the pluvial phases conditions in general would have been more favourable for plant life than they are to-day. Consequently areas such as the Karroo, which to-day has a rainfall too low to permit the presence of the Cape flora, would in the past have been able to maintain this type of plant community. During the arid phases conditions over much of the country would have been too severe for this flora, which would have survived only in places where adequate shelter from drought could be obtained. The mountains of the Cape Province form such a place in the semi-arid conditions of the present day, and in the writer's opinion these have formed a refuge in which the old flora of South Africa was preserved in arid times and from which it spread in pluvial periods. The presence of marine terraces, possibly of Pleistocene age, covering considerable areas of the coastal belt (4), show that much of the low-lying area to-day occupied by the Cape flora was not then available. This emphasises the importance of the mountains as a sanctuary for the ancient flora of the country. It is therefore possible that the significance of the mountains of southern Africa for plant life lies not so much in their value as paths of migration, but in their capacity to afford more favourable climatic conditions in the arid periods that have afflicted this country from time to time. This would help to explain the great concentration of species in the mountains of the Cape, a fact well known to all botanists in South Africa.

The evidence brought forward here tends to show that the particular genera with which this paper deals have occupied a much larger territory in the past than they do to-day. This clearly indicates that the law of Age and Area (29) is profoundly modified in the case of a very old flora subjected to climatic fluctuations not sufficiently drastic to be lethal over the whole area, but sufficiently large to bring about considerable changes.

Earlier in this paper it was pointed out that *Passerina* differed from the other genera discussed in that it showed two points of concentration for the species. It may well be significant that *Passerina* differs from these other genera in having a higher proportion of purely lowland species occupying distinctive ecological niches. Many of these species, if the views expressed here regarding the mountains be accepted, would then be regarded as relatively young.

The problem of the origin or the origins of the Cape flora still remains a mystery. In Permo-carboniferous times the land-masses of the southern hemisphere possessed a remarkably uniform flora (20) which was distinct from the contemporaneous northern flora. That flora was a pre-Angiospermous one. To-day in the southern hemisphere the floras have marked differences. In Africa the Cape flora is quite distinct from the

other African floras and bears a distant though definite relationship to part of the flora of Australia. This fact has continued to excite the interest of scientists since it was first discussed by Hooker (8) nearly eighty years ago. The idea that the Cape flora had its origin, at any rate in part, in the south has its adherents (7, 23) and in many ways is attractive. However, evidence from plant distribution in southern Africa all tends to point in the opposite direction, to a northern origin rather than a southern. The genera with which this paper deals all give support to a northern origin.

Lobostemon has all its relatives in the northern hemisphere of the Old World. *Echium*, a large northern genus, is so like *Lobostemon* that as recently as 1924 Johnston (9) merged the genera, though, as has been pointed out earlier, there is no justification for this procedure. *Echium*, together with several smaller genera, are separated from *Lobostemon* by the vast region of the Tropics, and all that may be inferred with certainty is that *Lobostemon* was more widely spread in southern Africa in past ages. There is no evidence to show that these genera or their ancestors once lived in tropical Africa. The fundamental difference in chromosome numbers suggests that the separation of these genera took place a considerable time ago. All that may be safely deduced from these facts is that nothing in *Lobostemon* indicates a southern origin for this element of the Cape flora.

Stoebe has a wider distribution extending into tropical Africa, Madagascar, and Reunion. Details have already been given. A point of interest is that all the species ranging outside the area of the Cape flora belong to one section of the genus and are clearly related. They, too, are the only ones which show marked discontinuity in their areas of distribution. The other section, with its species concentrated in the extreme south-west and with much smaller and overlapping areas of distribution, is presumably younger. If this be allowed, then it follows that this genus has travelled from the north southwards. As in the case of *Lobostemon*, a considerable age must be attributed to the genus. The fact that three species occur outside Africa, in Madagascar and Reunion, clearly points in this direction. Most geologists agree that Madagascar was once united to the mainland of Africa, though they are not in complete unanimity as to the date of separation. Du Toit places the final separation in the Oligocene (5), while Gregory (6) considers that it was in the Pleistocene that isolation occurred. In any case *Stoebe* must have been in existence before the actual date of separation, and therefore can lay claim to a respectable antiquity.

The evidence provided by these two genera, though incomplete, points northwards for their origin. One fact which might be used as an argument

for their southern origin lies in their concentration in the mountains of the south-west. Willis (29), in discussing the flora of New Zealand, argues that the point of concentration of species will indicate the place at which the original species entered the country. From this he finds that New Zealand shows three such points of concentration and has therefore presumably been populated by three separate plant invasions. An argument of this type will hold, provided that the floras are not very old and that great fluctuations of climate have not occurred. However, in a case such as that of South Africa, climatic fluctuations operating over a long period of time are likely to have modified the flora considerably on more than one occasion. Consequently, as has been pointed out earlier, the concentration of species in the mountainous regions of the south-west may have no connection with any question of origin, but may merely indicate a region where sanctuary was found in times of stress.

Palaeontological evidence, which in the north is providing much useful data in the reconstruction of past floras, has been of little assistance in determining the origin of southern floras. The presence of fossil members of the Proteaceae in the north has usually been regarded as doubtful. However, in a recent paper (21) Seward says: "My belief is that not a few of the specimens from Cretaceous and Tertiary rocks in North America and Europe have been correctly assigned to the Proteaceae." This, of course, is a purely tentative opinion, but coming from such a cautious palaeobotanist as Sir Albert Seward it merits attention. A little further on in the same paper he discusses the genus Eucalyptus, another southern genus, in this case all but confined to Australia. "Records of Eucalyptus leaves and fertile branches from northern hemisphere rocks are numerous and some of them furnish clear evidence for the occurrence of this Australian tree in both Cretaceous and Tertiary floras." Palaeobotany, though its evidence be meagre with regard to the southern floras of Cretaceous and post-Cretaceous age, indicates that characteristic plants of the southern hemisphere were represented in the north in times not long after the origin of the Angiosperms. It is to be hoped that further researches will throw light on this subject. It does appear likely that some characteristic plants of the south to-day were in existence in the north in Cretaceous and Tertiary times, and this strengthens the case for those advocating a northern origin of the southern floras.

Fossils obtained in the southern hemisphere have given little information. Many which have been obtained from Antarctica belong to the Glossopteris flora and therefore have no bearing on our present problem. It is well known that in Palaeozoic times the floras of the southern hemisphere were strikingly similar, but that similarity was not carried on into the later geological periods.

Seward and Conway (22), in dealing with Araucarian fossils from the Kerguelen Archipelago, discuss the question of the past climate of those parts. The presence of an Araucarian forest on an island to-day incapable of supporting a plant community of this type indicates that the climate was once more favourable than it is to-day. The authors refer to the assumption that at one time Antarctica enjoyed a subtropical climate, and state that "such an assumption would be difficult to defend."

At present it is futile to speculate upon the origins of the Cape flora as a whole. The data are wholly insufficient. It will be of special interest to know more about the natural relationships and distribution of the species comprising large genera belonging to the families which suggest an Australian affinity. Detailed studies on the natural relationships and distribution of members of the Proteaceae would probably be a fruitful line of research. The object of this paper is to put on record a number of facts of distribution. These do not support a southern origin of the Cape flora, and it must be left to the future to show whether the conclusions drawn from these facts are of general application or not.

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FIG. 1.—Cape flora on the top of a kopje at Ladismith. The two large plants in the foreground are *Protea macrophylla*.

FIG. 2.—Kopjes near Ladismith. The northern slopes of two kopjes are seen with bushes of various succulents dotted about. The southern slope of one kopje is shown largely in shade, but just beyond the shadow a uniform covering of rhenosterveld may be seen.